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Aluminum and Its Alloys

USSR

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EFFECT OF PRIOR FORGING OF AN INGOT ON THE STRUCTURE AND PROPERTIES OF EXTRUDED INTERMEDIATE PRODUCTS MADE FROM D16, AK4-1 and 1201 ALUMINUM ALLOYS

Moscow IAN SSSR, METALLY in Russian No 2, Mar/Apr 78 pp 145-150 manuscript received 6 Apr 77

SHTOVBA, YU. K., TELESHOV, V. V., and KOZLOVA, O. M., Moscow

[Abstract] The structural changes in ingots and extruded intermediate products made from aluminum alloys were studied. Ingots 370 mm in diameter were produced from alloys D16 (4.22 Cu, 1.43 Mg, 0.53 Mn, 0.25 Fe and 0.12 Si), AK4-1 (2.25 Cu, 1.60 Mg, 1.12 Fe, 1.02 Ni, 0.2 Si and 0.1 Ti) and 1201 (6.29 Cu, 0.29 Mn, 0.12 Fe, 0.06 Ti 0.18 Zr and 0.07 V(chemical composition in %). After batch homogenization the ingots were extruded into 120-mm-diameter rod and T-shapes (5 x 100 - 20 x 120 mm) with drawings of 8 and 23 respectively. Intermediate products were also extruded from the homogenized ingots. Tensile and impact strengths were determined, grain size and shape evaluated and quantity and parameters of the excess phase inclusion distribution also determined. Fatigue strength was tested. The use of forged ingots in the manufacture of aluminum intermediate products leads to changes in their grain structure, promotes more uniform distribution of the excess phases in the alloy volume and, in alloy D16, refines the inclusions of the insoluble phases. The observed structural changes increase ductility and impact strength of the extruded alloys, especially in the transverse direction. The increase in average dimensions of excess phase inclusions and grain size in AK4-1 alloy rods, caused by using a forged ingot, leads to a significant loss of fatigue strength in the extruded intermediate product while at the same time a decrease in the same structural parameters increases fatigue strength in D16 alloy intermediate products. Thus the use of aluminum alloy forged ingots can in many cases lead to undesirable consequences and must be considered when selecting the technology to produce intermediate products. Figures 3; references 6: 4 Russian, 2 Western.

USSR

UDC 620.18:669.715

## INTERMETALLIDES AND THE DEVELOPMENT OF FATIGUE CRACKS IN DURALUMIN

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2,  
1978 pp 28-30

GOL'DENBERG, A. A., YEKIMENKOV, L. N., ANTIPOVA, L. N., All-Union Correspondence Institute of Metallurgy

[Abstract] Electron microscope studies of various stages of fracture and fracture surfaces indicate that the mechanism of action of inclusions during cyclical loading of a specimen is as follows: stresses arise at the boundary between intermetallide particles and the solid solution due to the difference in elasticity moduli. At certain moments in time, the stresses due to the external load are added to the induced internal stresses, and fractures begin to propagate from the boundaries of intermetallides even before the approach of the fatigue crack, so that the main crack develops primarily toward the inclusions, changes its direction and branches. The mean radius of action of an inclusion on crack development depends on the size of the inclusion, increasing linearly with an increase in the logarithm of its mean diameter. The calculated results agree well with experimental results for inclusions over 2  $\mu\text{m}$  in diameter. Figures 5; references 4 (Russian).

USSR

UDC 669.715:620.183

## INVESTIGATION OF THE NEAR-SURFACE LAYER IN 01420 ALUMINUM ALLOY

Moscow IAN SSSR, METALLY in Russian No 2, Mar/Apr 78 pp 220-222 manuscript received 28 May 76

FRIDLYANDER, I. N., SANDLER, V. S., NIKOL'SKAYA, T. I., SAVINKOV, R. A., and ROSHCHINA, I. N., Moscow

[Abstract] The surface and near-surface layers of 01420 aluminum alloy sheet and model binary Al-6% Mg and Al-2% Li alloys were studied. The structure of compounds formed on the surface of these alloys after heating to 450 and 500°C for 1-10 hours was determined. Oxidation of 01420 alloy occurs with formation of MgO and Li<sub>2</sub>CO<sub>3</sub>. Oxidation is slowed but not completely retarded when heating is done in a vacuum. Surface oxidation causes depletion of the Mg and Li in the near-surface layers with the depth of the depleted layer increasing with increased heating temperature and time, leaving it weak. The process of depletion is accompanied by micropore formation with pore distribution being in the form of a stretched mass whose boundaries migrate to the sample core. The pores, which are of the vacancy type, form as the result of

equalizing diffusion of the alloying components to the sample surface. Microstructural analysis of the two model alloys, after heating at 450 and 500°, showed that the prevailing effect on pore formation in alloy 01420 turns out to be diffusion of Li and not Mg. No pores were noted in the alloy with Mg. Figures 4; references 3 (Russian).

USSR

UDC 669.715:669.018.2

EFFECT OF ORIENTED INCLUSION DISTRIBUTION ON THE ANISOTROPY OF ALUMINUM ALLOY PROPERTIES

Moscow IAN SSSR, METALLY in Russian No 2, Mar/Apr 78 pp 209-213 manuscript received 6 Jul 76

VAYNBLAT, YU. M. and KOPELIOVICH, B. A., Moscow

[Abstract] A study was made to find the quantitative principles which determine the effect of inclusions on the level and anisotropy of properties in aluminum alloys D16, AK8, V93, V95 and V96, to find a means of describing the parameters of the stringer structure and to investigate the correlation of these parameters with mechanical properties. A metallographic method was developed to study stringer inclusion distribution and their mathematical description with the aid of the theory of random functions. The concept of effective volume fraction of inclusions for a given direction in a deformed alloy was introduced which was the average local inclusion distribution in zones where it is higher than the average value for the alloy volume. It was shown that the relative elongation of longitudinal and transverse samples can be associated, by the general linear relationship, with the effective inclusion density. The anisotropy in ductility, characterized by differences in values of elongation, is determined by the parameters of oriented inclusion distribution and is independent of the matrix properties. Figures 5; references 8: 4 Russian, 4 Western.

## Analysis and Testing

USSR

UDC 620.17:620.179.14

### THE USE OF STATISTICAL METHODS IN NONDESTRUCTIVE TESTING OF THE MECHANICAL PROPERTIES OF HIGH QUALITY CARBON SHEET STEEL

Sverdlovsk DEFECTOSKOPIYA in Russian No 2, Feb 78 pp 49-52 manuscript received 28 Feb 77

DEVYATCHENKO, L. D., YESIPOV, I. V., BATURINA, S. K., KIRILLOVA, G. K., and PAKHOMOVA, N. YE., Magnitogorsk Mining and Metallurgical Institute; Magnitogorsk Metallurgical Combine

[Abstract] A mathematical model is developed and studied for nondestructive testing of the mechanical properties of hot rolled high quality carbon sheet steel using the TK-IM contact hardness meter, the IMA-2A magnetic pulse analyzer and the KIFM-IM ferroprobe coercitometer. The correlation-regression relationship between the mechanical characteristics of the metal (ultimate strength, relative elongation and grain size), hardness and magnetic characteristics (coercive force and residual induction) were studied with these instruments as a function of sheet thickness. The testing established that for blanks 300x300 mm and larger in size with constant sheet thickness, the indications of the coercitometer and magnetic analyzer provide reliable predictions of mechanical properties. Use of these tests at the metallurgical combine has allowed a significant reduction in the volume of destructive testing while maintaining the reliability of prediction of mechanical properties of hot rolled sheet steel. The time required for testing is reduced by a factor of 8-10, and an annual savings of 16,000 rubles has been achieved.

References 4 (Russian).

USSR

UDC 620.179.16

### DETERMINATION OF THE DIMENSIONS OF CRACKS BY THE ULTRASONIC METHOD

Sverdlovsk DEFECTOSKOPIYA in Russian No 2, Feb 78 pp 8-12 manuscript received 2 Feb 77

GRIGOR'YEV, M. V., GREBENNIKOV, V. V., and GURVICH, A. K., Scientific Research and Design Institute for Installation Technology, Moscow

[Abstract] Ultrasonic defectoscopic methods of determination of the dimensions of cracks can be divided into amplitude, time and spectral methods. This work presents a review of the Soviet and foreign literature on these three methods of determining the dimensions of fatigue and corrosion cracks developing from the surface of metal products. Methods based on recording of the amplitude of the echo signal in most cases are not sufficiently accurate.

Time methods, using both surface and body waves, are more effective for determination of crack dimensions than amplitude methods. Spectral methods, in the early stage of development, are also promising. Figures 5; references 23: 9 Russian, 14 Western.

USSR

UDC 620.179.18

NONDESTRUCTIVE TESTING OF THE DEPTH OF THE NITRIDED LAYER IN PARTS OF AUSTENITIC MANGANESE-ALUMINUM-VANADIUM STEEL

Sverdlovsk DEFECTOSKOPIYA in Russian No 2, Feb 78 pp 52-57 manuscript received 23 Sep 77

BELENKOVA, M. M., VAGANOVA, L. A., VITKALOVA, R. N., KOGAN, L. KH., and MIKHEYEV, M. N., Institute of Metal Physics, Academy of Sciences USSR

[Abstract] A detailed study is presented of the magnetic and electrical properties of the F2 austenitic dispersion-hardened steel after various modes of chemical and heat treatment in order to clarify the physical picture of the processes occurring during austenitization, aging and nitriding and to determine the possibility of development of nondestructive methods of testing of products following these treatments. The steel was austenitized at 990-1240°C, cooled in oil to room temperature and aged at 620°C for 15 hours and at 470, 500, 720 and 770°C after normal austenitization at 1130°C. Increasing austenitization temperature causes a slight increase in resistivity. Nitriding causes a great change in magnetic properties, all specimens becoming ferromagnetic. The conductivity of nitrided specimens is also unambiguously related to the depth of the nitrided layer. The magnetic permeability clearly depends on the depth of the nitrided layer. This makes nondestructive methods of testing of the depth of the nitrided layer a clear possibility. Figures 3; references 7: 6 Russian, 1 Western.

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## Beryllium

USSR

UDC 669.15'725:620.187.3:539.27

ON A FOUR-PHASE MODEL OF THE STRUCTURE OF IRON-BERYLLIUM ALLOYS IN THE INITIAL STAGES OF AGING

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 45 No 2, Feb 78  
pp 315-326 manuscript received 27 Jan 77

TYAPKIN, YU. D., YEVTSUSHENKO, T. V. and TRAVINA, N. T., Institute of Physical Metallurgy and Metal Physics, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] A detailed study was made of structural changes in Fe-Be alloys with 16.5 (ZhB16) and 19.5 (ZhB19) at. % Be in different stages of aging at 300-500°C using methods of micro-diffraction and diffusion scattering of x-ray beams for the purpose of establishing the principles of four-phase structure formation. The four-phase structure is formed only after aging ZhB19 for two hours and ZhB16 for four hours both at 400°C and consists of the alpha'-phase (I), two transitional tetragonal phases (II and III) and an alpha solid solution with the structure being clearly heterogeneous in Be distribution around the alpha'-phase nucleus. From a metastable Fe-Be phase diagram it was noted that the transformation starts either with type B2 ordering throughout the entire volume with subsequent decomposition--precipitation of the alpha'-phase of FeBe (aged below 350°C) or immediately with precipitation of alpha'-phase regions enriched with Be with the simultaneous type B2 ordering only in these regions. It was established that in regions of types I, II and III, ordering of the Be atoms occurs with decreased degree in the sequence I→II→III in conjunction with change of Be content (28→21→15 at. %). Type IV regions (cubic lattice) were not ordered (11 at. % Be). Figures 8; references 16: 6 Russian, 10 Western.

## Composite Materials

USSR

UDC 669.71:539.4.019.2

### ROLE OF BRITTLE LAYERS IN THE BEHAVIOR OF FIBROUS COMPOSITES AT ELEVATED TEMPERATURES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 78 pp 44-50 manuscript received 10 Apr 77

KARPINOS, D. M., MAKSIMOVICH, G. G., LYUTYY, YE. M., FILIPOVSKIY, A. V., and KADYROV, V. KH., Physico-Mechanical Institute and the Institute of Problems of Material Science, Academy of Sciences Ukrainian SSR

[Abstract] The effect of transition layers on the strength of composites made from AD1 aluminum alloy with fibers of N16K4M5T steel (diameter--120 microns, volume--30%) and tricot-network lattices of Kh18N10T steel (diameter--100 microns, volume--10 and 22%) was studied at elevated temperatures. The AD1-N16K4M5T composite was annealed in argon at 540°C for 1, 1.5, 2, 10, 50 and 100 hours and the AD1-Kh18N10T--at 580° for 0.5, 2 and 5 hours. These heat treatments produced transition layers of varying thickness. The intermetallic compounds formed adjacent to the matrix were FeAl<sub>3</sub>-base solid solutions while those next to the fibers were Fe<sub>2</sub>Al<sub>5</sub>-base solid solutions. When transition layer thickness reaches 12 microns for the composite with the lattice reinforcement strength is decreased by 15% for a volume content of 22% and by 24% at a volume content of 10% in comparison to the initial material. At 21 microns thickness the values of strength loss are 24% for a 22% volume content and 39% for a 10% volume content. Strength is increased with increased thickness of transition layer up to a critical thickness which is not stated for any of the materials tested. As temperature increases the structural stability of the composite increases although strength decreases somewhat. Figures 5; references 12: 9 Russian, 3 Western.

USSR

UDC 669.71:532.78

### STUDY OF THE CONDITIONS OF CRYSTALLIZATION AND FORMATION OF THE STRUCTURE OF THE ALUMINUM MATRIX IN THE PRODUCTION OF CAST COMPOSITE CORDS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan/Feb 78 pp 138-142 manuscript received 4 May 77

SEMENOV, B. I., KHANIN, YE. I., and MARKEVICH, YU. B.

[Abstract] A study is made of the thermal conditions under which crystallization of the matrix of a cast cord and formation of its structure occurs. Significant supercooling of the melt of the matrix is observed in the process of production of cast cords in the AD-1 aluminum alloy plus boron system by continuous casting methods. Directed solidification of the matrix reduces porosity and assures preferential orientation of crystalline boundaries along the reinforcing fibers. Figures 6; references 11: 8 Russian, 3 Western.

USSR

UDC 539.216.2:669.71

COMPOSITE MATERIALS AND COATINGS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan/Feb 78 pp  
149-151 manuscript received 20 Jun 77

KARPINOS, D. M. and ZIL'BERBERG, V. G., Kiev

[Abstract] The Institute of Problems of Mechanics, Academy of Sciences Ukrainian SSR has developed and studied a number of composite coatings and materials based on them. They include ceramic, cerametallic and metallic coatings and materials containing dispersion-hardening or reinforcing additives. Plasma technology has been found to have an advantage over other technologies in the creation of such materials and coatings. Examples are presented of composite materials and coatings with high thermal stability and strength. References 13 (Russian).

Concrete

USSR

METON--A NEW CONSTRUCTION MATERIAL

Moscow STROITEL'NYYE MATERIALY in Russian No 3, Mar 78 p 11

SOLOMATOV, V. I., dr of technical sciences, Moscow Order of Lenin and Order of the Red Banner of Labor Institute of Railway Transportation Engineers, POTAPOV, YU. B., candidate of technical sciences, Mordov State University imeni N. P. Ogarev

[Abstract] Meton (metal-concrete) is a synthetic structural conglomerate using metallic binders and mineral or other fillers. The new mineral can be qualified as a concrete in which the role of cement (polymers, limestone) is fulfilled by metals such as Al, steel, cast iron, Ti, Cu, Pb, Sn and Zn in amounts of 15-50% by volume as binders. Gravel and sand from diabase, quartz, basalt, granite and other minerals and rock serve as fillers. The technology of producings meton is pouring a mixture of fillers in a form and then filling it with metal or filling in the form and packing a mixture of fillers and metal grains with subsequent heating to a temperature above the melting point of the metal. For example the compressive strength of an aluminum meton is 1.5 times stronger than the pure metal and 10 times stronger than concrete. Use of meton parts and constructions will reduce metal consumption by 2-6 times with a simultaneous increase in a number of technical and operational properties.

Conferences

USSR

UDC 621.791:061.3

SEMINAR ON SHEET WELDMENT ACCURACY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 3, Mar 78 p 78

GRUZD, A. A., Candidate of Technical Sciences

[Abstract] An All-Union Scientific Technical Seminar was held 25-28 Oct 77 in Kiev on the theme "Providing Sheet Weldment Accuracy in the Process of Their Design, Manufacture and Use." A. Ya. NEDOSEK, Doctor of Technical Sciences (Institute of Electric Welding), opened the seminar by discussing basic directions of research into weldment accuracy. V. I. MAKHNENKO, Doctor of Technical Sciences (Institute of Electric Welding), gave a lengthy analysis on methods of calculating the stress-strain state of weldments and the prospects of using computers to perform these calculations. A. G. GRIGOR'YANETS, Doctor of Technical Sciences, and S. I. YERMAKOV, engineer (Moscow Higher Technical School), reported on the use of special equipment to study formation of residual stresses and strain in a number of metals by employing the thermal-physical and mechanical properties of the welded metal in relation to temperature. Yu. G. KUTSENKO (Kiev) reported on an automatic data-measuring system for studying stress and strain. A. Ye. KOROTYNSKIY, Candidate of Technical Sciences (Institute of Electric Welding), discussed problems of automating experiments and creating universal means of measuring and evaluating the deformation-strength properties of weldments. A number of reports were given on methods and means of decreasing weld strains: V. M. SAGALEVICH, Doctor of Technical Sciences--method and equipment for lowering strain in welded T-shapes; V. V. BATYUK, Candidate of Technical Sciences, et al--sheet weldments in precision instrument making; A. I. LEBEDEV, Candidate of Technical Sciences--advantages of tabular-norm allowances for weld strains; B. V. MEDKO, Candidate of Technical Sciences, et al--deformation in the welding of titanium alloy elements; V. S. GASHENKO, engineer--accuracy in multilayer cylindrical weldments from coil steel; L. B. GERSHBERG, engineer--accuracy and geometric stability of welding equipment; V. M. GOLIN'KO, engineer--accuracy of welded roll lengths of sheet construction; L. M. LOBANOV, Candidate of Technical Sciences, et al--method of prior elastic strain in the welding of round joints into cylindrical shells; and V. P. ABROSIMOV, engineer--method of heat treating for correcting shell weldments. Ya. I. BURAK, Doctor of Technical Sciences (L'vev), reported on results of computing the optimum modes of heating the joints of cylindrical shells. O. I. GUSHCH, Candidate of Technical Sciences (Institute of Electric Welding), and A. N. GUZ', Doctor of Technical Sciences, discussed the method, equipment and results of determining residual stresses using ultrasonics. V. A. KARKHIN, Candidate of Technical Sciences (Leningrad), reported on results, development and use of an original method of a finite element for calculating welding temperature fields. Yu. A. DENISOV, Candidate of Technical Sciences (Kurgan), et al, presented a report on a method for evaluating residual stresses from the lateral shrinkage of weld seams. I. V. PARKHOMENKO, Candidate of Technical Sciences (Institute of Electric Welding),

T. M. SHVETS, Candidate of Chemical Sciences, et al, discussed their experiences in the use of photoelastic coatings to study residual stresses and, in particular, redistribution of stresses in aluminum sheet elements after back welding. A. Ya. NEDOSEK and G. I. GORLENKO, engineers (Institute of Electric Welding), reported on the results of investigating plastic deformation and residual stresses in precision welding. V. G. PETUSHKOV, Candidate of Technical Sciences (Institute of Electric Welding), et al, reported on a nondestructive method of determining residual welding stresses. A. A. GRUZD, Candidate of Technical Sciences, told about the effective use of ultrasonic treatment in weldments. I. G. POLOTSKIY, Doctor of Technical Sciences, and G. I. PROKOPENKO, Candidate of Physical-Mathematical Sciences, reported on ultrasonic methods of lowering residual welding stresses and surface strengthening. Ye. Sh. STATNIKOV, engineer, et al, reported on the regulation of residual stresses from warping and on the use of the ultrasonic impact treatment method of determining welding joint strength. The next seminar will be held in 1979.

Corrosion

USSR

UDC 620.194

METHODS OF PROTECTING HIGH STRENGTH WELDABLE STAINLESS STEEL FROM CORROSION CRACKING

Moscow ZASHCHITA METALLOV in Russian Vol 14 No 2, Mar/Apr 78 pp 138-142 manuscript received 1 Nov 76

LASCHEVSKIY, V. B., GURVICH, L. YA., BATRAKOV, V. P., KOZHEUROVA, N. S., MOLOTOVA, V. A., and SHVARTS, M. M., All-Union Scientific Research Institute of Aviation Materials

[Abstract] A study is made of the effectiveness of protection of type 08Kh15N5D2T high strength weldable stainless steel and type 1Kh15N4AM3 steel from corrosion cracking by metallization (gas flame atomized), galvanic and paint coatings, sealers and lubricants. The primary object of the investigation was welded joints in 08Kh15N5D2T steel with 0.10 and 0.07% titanium under a stress applied by bending of 100 kg/mm<sup>2</sup> in a salt fog and in an SO<sub>2</sub> atmosphere. Metallization with aluminum and zinc effectively increases the corrosion resistance in salt fog. Galvanic coating with Cd, Zn and Cr increases salt fog resistance as well; a chemical nickel coating increases salt fog resistance to a lesser extent, while chemical silver coating has no effect. Paint coatings provide protection in the following decreasing order: epoxy-polyamide enamel; acrylic enamel; organosilicon enamel; primer alone (insufficient protection). Type KhS-596 inhibiting coating is effective against both salt and SO<sub>2</sub>. Organosilicon sealers are effective, as are various protective oils and greases. Figure 1; references 9: 7 Russian, 2 Western.

USSR

UDC 620.193

INFLUENCE OF NICKEL ON THE ANODIC BEHAVIOR OF TITANIUM IN RIVER WATER

Moscow ZASHCHITA METALLOV in Russian Vol 14 No 2, Mar/Apr 78 pp 169-171 manuscript received 13 Nov 76

STEPANOVA, T. P., KRASNOYARSKIY, V. V., TOMASHOV, N. D., and DRUZHININA, I. P., Academy of Sciences, Institute of Physical Chemistry

[Abstract] A study is presented of the influence of nickel on the physical-chemical properties of titanium and its anodic characteristics in river water. Potentiokinetic anodic polarization curves and potentiostatic curves of potential vs. corrosion rate, determined by weighing, were measured in river water at 20°C. The studies indicate that nickel greatly increases the electron conductivity of films based on its alloys with titanium. The optimal conductivity is reached in an alloy similar in composition to Ti<sub>2</sub>Ni. Figures 2: references 3 (Russian).

USSR

UDC 620.193.4

CORROSION OF TITANIUM AND ITS ALLOYS WITH NICKEL AND PALLADIUM IN ZINC CHLORIDE SOLUTIONS

Moscow ZASHCHITA METALLOV in Russian Vol 14 No 2, Mar/Apr 78 pp 172-175  
manuscript received 29 Oct 76

MAMYLIKINA, M. V. and ROMANUSHKINA, A. YE.

[Abstract] Variation of corrosion as a function of concentration of  $ZnCl_2$  solutions, their acidity and temperature was studied under static conditions and in a stream in a glass apparatus. The specimens were also tested in industrial and laboratory evaporators at various temperatures and pressures. Polarization measurements indicate that titanium and its alloys are well passivated with a  $ZnCl_2$  concentration of up to 75% at temperatures of up to 135°. The titanium alloy 4200 with 0.2% palladium is suitable for the manufacture of evaporation apparatus for  $ZnCl_2$  solutions acidified with hydrochloric acid. Figures 2; references 4: 2 Russian, 2 Western.

USSR

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CORROSION OF METALS IN THE OCEAN AT VARIOUS DEPTHS

Moscow ZASHCHITA METALLOV in Russian Vol 14 No 2, Mar/Apr 78 pp 176-179  
manuscript received 25 Aug 76

ULANOVSKIY, I. B. and YEGOROVA, V. A., Academy of Sciences, USSR, Institute of Oceanography, Southern Division

[Abstract] A study is presented of the corrosion rate of type St.3 steel, type 2Kh13 stainless steel, the aluminum alloys AMg-6 and AMtsM, type M-1 copper and type LS-59 brass in the northwestern Pacific Ocean. Studies were performed at depths of 10 to 5500 m using frames suspended from hydrologic buoys. The specimens were ground and degreased before testing. Analysis of the results shows that hydrostatic pressure has no significant influence on the processes of corrosion of these metals. Corrosion is practically constant at all depths below 300 m, correlating well with temperature. References 6: 4 Russian, 2 Western.

USSR

UDC 620.193.2:669.788

INFLUENCE OF ELECTROLYTIC HYDROGENATION ON GAS CORROSION OF TITANIUM, IRON,  
NICKEL AND COPPER

Moscow ZASHCHITA METALLOV in Russian Vol 14 No 2, Mar/Apr 78 pp 201-202  
manuscript received 21 Jun 76

SPICHKIN, YU. V., VORONTSOV, YE. S., YEMEL'YANOV, D. YE., and SHATALOV, V.  
V., Voronezh Polytechnical Institute

[Abstract] The method of interference indication is used to study the influence of electrolytic hydrogenation on the chemical stability of titanium, iron, cast and galvanic nickel and copper in air. It is established that as a result of hydrogenation, the oxidation rate of Cu and Fe decreases significantly, Ti--less significantly, while Ni, both melted and electrolytically deposited, is accelerated. The method of interference indication thus illustrates the unique relationship between the degree of electrolytic hydrogenation of Ti, Fe, Ni and Cu and their corrosion resistance in the atmosphere.  
Figure 1; references 5 (Russian).

USSR

UDC 620.193.41

CORROSION OF TITANIUM IN ETHYLENECHLOROHYDRINE SOLUTIONS OF HYDROGEN CHLORIDE

Moscow ZASHCHITA METALLOV in Russia. Vol 14 No 2, Mar/Apr 78 pp 182-183  
manuscript received 26 Jul 76

KOMAROVA, L. I. and MAKSIMKINA, L. M., Kemerov Technological Institute of  
the Food Industry

[Abstract] A study was made of the corrosion and electrochemical behavior of VT-1 titanium in ECH with HCl content up to 5%, H<sub>2</sub>O from 0.02 to 80%. It was found that the addition of water to ECH solutions of HCl has a significant inhibiting effect. Addition of 1% water decreases the corrosion rate of a 3% HCl solution by a factor of 1.5. The addition of H<sub>2</sub>O increases the stability of the surface layer, apparently due to the oxidizing effect of the oxygen in the water. For each solution there is a certain critical concentration of water, beginning with which the passivity of the surface layer of the titanium increases greatly and anodic dissolution of the metal is inhibited.  
Figures 2; references 5 (Russian).

Forming

USSR

UDC 621.771.23:621.89

CHARACTERISTICS OF HOT ROLLING SHEET STEEL WITH APPLICATION OF A SILICATE MELT

Moscow IVUZ, CHERNAYA METALLURGIYA in Russian No 2, Feb 78 pp 74-78 manuscript received 24 May 77

CHELYSHEV, N. A., KADYKOV, V. N., TARASKO, D. I., FASTYKOVSKIY, A. R., and MIROCHNIK, S. M., Siberian Institute of Metallurgy

[Abstract] Laboratory and industrial experiments using a glass melt as both heating agent and lubricant for the rolling of sheet steel have revealed a reduction of power and force requirements for this process to approximately half the conventional level. Two grades of glass were used, containing 37-40%  $\text{SiO}_2$  + 3%  $\text{Al}_2\text{O}_3$  + 25-26%  $\text{Na}_2\text{O}$  + 21-26%  $\text{B}_2\text{O}_3$  + alkaline-earth oxides. The test results are confirmed by a calculation of static and dynamic process parameters from steel grades 08kp and E3A. The quality of the product has also been evaluated and found high on the basis of profilographic surface measurements and thickness gauging for uniformity. Figures 3; references 4 (Russian).

## Mechanical Properties

USSR

UDC 539.4:539.216.2

### THE MECHANICAL PROPERTIES OF TWO-LAYER Al-Be FOILS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan/Feb 78 pp 143-148 manuscript received 11 Apr 77

KOSTANDOV, YU. A., PAPIROV, I. I., KAPCHERIN, A. S., and TITOV, B. F., Knar' Kov

[Abstract] The purpose of this work was to produce and study the properties of two-layer Al-Be foils, which are interesting as initial materials for the production of Al-Be composites which can be used as windows for the transmission of particles and radiation, and also as targets in nuclear research. The complex nature of the variation of strength characteristics of two-layer Al-Be foils with Be layer thickness is explained by the effect of the rule of additiveness of the properties of the components, considering the increase in strength of the beryllium foil as its thickness decreases. The increase in strength of two-layer Al-Be foils as Be thickness decreases from 4 to 2  $\mu\text{m}$  results from an increase in the strength of the condensed Be film with a decrease in its thickness. The maximum strength ( $6.8 \text{ kg/mm}^2$  for annealed specimens) is manifested by two-layer foils with a Be layer thickness of 2  $\mu\text{m}$ . The yield point of condensed beryllium films increases from 13 to  $56 \text{ kg/mm}^2$  as Be thickness decreases from 3 to 0.5  $\mu\text{m}$ . The significant increase in Be tensile strength at film thicknesses of less than 3  $\mu\text{m}$  results from the effect of the scale factor, together with the decrease in crystal size and the change in texture. Figures 4; references 15 (Russian).

USSR

UDC 539.26+620.183.25

### MECHANICAL PROPERTIES AND STRUCTURAL HETEROGENEITY OF METAL CERAMIC TUNGSTEN

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 78 pp 100-104 manuscript received 23 Jun 77

GNUCHEV, V. S., ZASIMCHUK, YE. E., KAS'YAN, K. N., KRAVCHENKO, V. S., RABINOVICH, YE. M., KHARCHENKO, V. K., and SHEINA, I. V., Institute of Problems of Strength, Academy of Sciences Ukrainian SSR

[Abstract] Analysis of a large number of samples shows that the differences in structure observed during rolling of sheets and plates of tungsten by hot-rolling of sintered blanks represents a combination of three types of structures, arbitrarily classified by grain size. In order to determine the influence of possible deviations from the temperature mode of manufacture of the sintered tungsten on the formation of varied grain sizes, the dynamics

of change in dimensions of grains of the optimal medium grain structure in the process of high temperature annealing was studied. Specimens were annealed for 15 minutes to 5 hours in a vacuum at 1600-2400°C. It was found that the temperature interval of secondary recrystallization of tungsten in annealing is 2000-2200°C. Since the maximum rolling temperature is 1700°C, the difference in grain size observed cannot result from secondary recrystallization. The structural heterogeneity may result from another process--primary recrystallization--resulting principally from the quantity and distribution of impurities and finely dispersed inclusions rather than temperature variations during rolling. Figures 5; references 6: 5 Russian, 1 Western.

Powder Metallurgy

USSR

UDC 621.762.4

PRODUCTION AND STUDY OF PROPERTIES OF POWDERED TITANIUM ALLOYS CONTAINING Mo, Zr AND Nb

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 78 pp 91-95 manuscript received 20 May 76

PAVLOV, V. A. and AVRUNINA, G. V., Zaporozhye Machine Building Institute imeni V. Ya. Chubar'

[Abstract] A search is made for powdered alloying additives and improvements to the technological process of production of products, in order to create conditions under which it is possible to replace expensive cast titanium alloys with powder alloys. It is found that as Ti powder alloys are given increasing contents of alloying additives, the pressure of extrusion following preliminary sintering increases. Alloying with Mo, Zr and Nb significantly increases the strength of powdered titanium products, more than doubling it with 9% Mo (with a slight decrease in ductility). The microstructure of powdered alloys in the Ti-Zr system (1-9% Zr) is typical for one-phase cast alloys; the microstructure in the Ti-Mo system and Ti-Nb system (also with 1-9% Mo and Nb) is typical for two-phase ( $\alpha+\beta$ ) alloys. To produce a homogeneous structure, high temperature annealing should be performed after hot extrusion. Figures 2; references 6 (Russian).

USSR

UDC 621.762.4:621.384

SOME PROPERTIES AND THE ELECTRON STRUCTURE OF SEVERAL MODIFICATIONS OF BORON

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 78 pp 61-66 manuscript received 20 May 77

ZHURAKOVSKIY, YE. A., PADERNO, YU. B., ZADVORNYY, L. I., BONDARENKO, T. N., DZEGANOVSKIY, V. P., and IVANCHENKO, L. A., Institute of Problems of Material Science, Academy of Sciences Ukrainian SSR

[Abstract] A study is made of a number of properties and certain details in the electron structure of several modifications of boron, and some characteristics of boron specimens produced both by melting and by methods of powder metallurgy are compared. The study was performed on powders (x-ray, chemical and spectral analysis; reflection spectra, chemical stability, x-ray spectra) and on compact specimens (resistivity, microstructure, microhardness). The electrophysical and microstructural studies of  $\beta$ -boron indicate that specimens of the best quality can be obtained by vacuum electron beam melting and vacuum sintering. Analysis of the bands produced by the RSM-500 x-ray spectrometer shows that the distribution of occupied p states in amorphous boron

and  $\alpha$  and  $\beta$ -boron is similar. The x-ray spectral data indicate great similarity in the electron structure of amorphous and  $\beta$ -boron; the optical data indicate great similarity between amorphous and  $\alpha$ -boron. It is noted that the similarity of optical spectra may result from the presence of microimpurities, to which the x-ray spectra are less sensitive. Figures 3; references 12: 8 Russian, 4 Western.

USSR

UDC 666.661.55

REGULARITIES OF SHAPING OF MATERIALS BASED ON ALUMINUM OXIDE AND THE NITRIDES OF TITANIUM AND ZIRCONIUM

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 78 pp 45-47 manuscript received 21 Jul 77

YEGOROV, F. F. and STOROZH, B. D., Institute of Problems of Material Science, Academy of Sciences Ukrainian SSR

[Abstract] A study was made of a powder of aluminum oxide of 99.72% purity, titanium nitride containing 0.4% C and 0.02% Fe, and zirconium nitride containing 86.4% Zr, 11.6% N, 0.11% Fe and 0.6% C. The mean particle diameter of the initial powder after vibration milling was about 1  $\mu\text{m}$ . The regularities involved in compacting were studied by dilatometry and resistivity studies with heating at a constant rate of 10°C/min and isothermal holding in a vacuum, in pure argon and highly pure nitrogen. It was established that when sintered in nitrogen, the  $\text{ZrN-Al}_2\text{O}_3$  composite acts as a reactive substance, forming  $\text{ZrO}_2$  and  $\text{AlN}$ , with an increase in the lattice period of  $\text{ZrN}$  and a decrease in microhardness, with  $\alpha\text{-Al}_2\text{O}_3$  converted to cubic  $\eta\text{-Al}_2\text{O}_3$  with  $a=7.92 \text{ \AA}$ . It is shown that the sintering process involves several stages with different predominant mass transfer mechanisms. Figures 4; references 6 (Russian).

USSR

UDC 669.018.45:66.0943:664.8:669.295

TITANIUM CARBIDE OXIDATION UNDER VARIABLE OXYGEN PRESSURE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 78 pp 55-61 manuscript  
received 8 Feb 77

VOYTOVICH, R. F. and GOLOVKO, E. I., Institute of Problems of Material Science,  
Academy of Sciences Ukrainian SSR

[Abstract] Results are presented from an investigation into the process of titanium carbide oxidation at oxygen pressures of  $10^{-5}$ ,  $10^{-1}$ , 10 and 150 mm Hg and temperatures of 500, 800 and 1000°C. In the oxidation process oxygen is dissolved in the carbide matrix and is accompanied by precipitation of carbon and metallic titanium to the surface layer for all pressure and temperature regions. The growth of the quantity of metallic inclusions with increased oxygen pressure is determined by the degree of carbon replacement in the carbide lattice. At a given pressure and temperature, oxygen inclusions enter into the lattice with the quantity of oxygen varying from grain to grain; at a pressure of  $10^{-3}$  mm Hg the number of inclusions is on the order of  $10^9/cm^2$ . Also, for all the temperature and pressure intervals it was noted that there was a weight gain caused by the formation of gaseous  $CO_2$ . Figures 5; references 21: 15 Russian, 6 Western.

USSR

UDC 621.793.72.533.9

STRUCTURE AND MECHANICAL PROPERTIES OF NICHROME PLASMA COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 78 pp 95-100 manuscript  
received 20 Jun 77

CHEVELA, O. B., ORLOVA, L. M., RYABICH, L. M. and CHERNYSHOVA, N. A.,  
Voronezh

[Abstract] The structural features of nichrome plasma coatings and their relation to strength properties were examined when sprayed on a substrate of 12Kh18N10T steel. It was found that the nichrome coating consisted of two phases—nichrome and chromium oxides. As the distance of spraying increases (above 80 mm) the width, extent and quantity of the second phase grows and the state of the coating-substrate transition zone improves. Tensile strength of the coating is determined by the amount of chromium oxide in the coating, while shear strength depends primarily on the state of the transition zone. Shifting of the nichrome wire from the nozzle center impairs coating quality, where the optimum distance of spraying the nichrome lies in the interval of 80-100 mm. Figures 6; references 5: 3 Russian, 1 East German, 1 Japanese.

USSR

UDC 621.762.5:669.295.011:621.794.61

## INCREASING THE FATIGUE STRENGTH OF SINTERED TITANIUM BY OXIDATION

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 78 pp 101-104 manuscript received 11 May 77

BEZRUCHKO, V. P., OGNEV, R. K. and KOLOMOYETS, G. G., Zaporozh'ye Machine Building Institute

[Abstract] The fatigue strength of sintered titanium, produced from grade PTES electrolytic titanium powder, was studied. Samples were sintered under a pressure of 5.5 and 7 t/cm<sup>2</sup> in a vacuum furnace at 1100°C and soaked for three hours at a residual pressure of  $4 \cdot 10^{-3}$  mm Hg. A portion of the samples were oxidized in a fluidized bed at 750°C for three hours. Oxidation causes development of residual compression stresses in the limits of the diffusion layer with a magnitude on the order of 7-10 kG/mm<sup>2</sup>. These stresses counteract the tensile stresses inside the material to a degree and prevent development of surface cracks but do nothing to protect against fatigue failure from internal cracks. Samples pressed under a load of 5.5 t/cm<sup>2</sup> and oxidized had a huge degree of brittle shear while those pressed under a load of 7 t/cm<sup>2</sup> had a large quantity of fine degrees of shear where crack propagation was of an unordered nature. These cracks, propagated in different directions, formed ahead of the main crack and jointly run together only by means of secondary shears. This diminishes the possibility of shear fracture and substantially increases resistance of the material to fatigue fracture. Figures 2; references 4: 2 Russian, 2 Western.

USSR

UDC 621.762

## OXIDATION OF BORON NITRIDE-BASE MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 78 pp 51-54 manuscript received 14 Dec 76

TSAPUK, A. K., PODOBEDA, L. G. and KOVALEVSKIY, N. N., Obninsk

[Abstract] Results are presented from a study of the oxidation kinetics of a boron nitride ceramic in a BN-SiO<sub>2</sub> composite with the pure BN ceramic produced from BN powders with a turbostratic structure by sintering in a nitrogen atmosphere at 1750°C for 1-2 hours. The BN-SiO<sub>2</sub> samples were provided by L. P. POLUBATONOVA. Samples were oxidized in platinum crucibles at 800-1300° and it was found that oxidation of BN starts at approximately 800°. When 8-10% of the BN has been oxidized the oxidation rate slows down and follows

the parabolic time law, indicating that molten boron trioxide possesses a barrier effect against oxygen accumulation on the BN surface. Presence of  $\text{SiO}_2$  reduces oxidation rate and increases the temperature of start of oxidation. Even though samples with  $\text{SiO}_2$  are more porous than the pure BN ceramic, the oxidation rate of the composite is less, which denotes the high protective properties of  $\text{SiO}_2$ . The activation energy for oxidation of BN is  $62 \pm 10$  kcal/mole. Figures 4; references 8: 4 Russian, 4 Western.

Steels

USSR

UDC 621.785.539

RELATIONSHIP OF THE SOLUBILITY OF STEEL IN MOLTEN ALUMINUM TO TEMPERATURE

Minsk IZVESTIYA AKADEMII NAUK BSSR, SERIYA FIZIKO-TEKHNICHESKIKH NAUK in Russian No 1, 1978 pp 57-59 manuscript received 27 May 77

LIVSHITS, S. L., ARTYUKHOV, A. I., PUKHOVSKIY, YE. P. and AREF'YEVA, O. N., Physical-Technical Institute BSSR

[Abstract] Samples of steel 45 measuring 6 x 5 x 20 mm were degreased in acetone and placed in molten aluminum for a specific time to study the resistance of steel to dissolution by the molten aluminum. The exposure time was one hour at melt temperatures of 700, 740, 780, 820 and 860°C. To determine solubility of iron in aluminum the following expression was employed:  $P_{Fe} = (C_{Fe}P_{Al})/100$  where  $P_{Fe}$  is the weight of iron in the aluminum ingot;  $C_{Fe}$  is the concentration of iron in the aluminum ingot (%) and  $P_{Al}$  is the weight of the aluminum ingot. A graph of the relationship of iron concentration in the melt to melt temperature shows that iron concentration increases with increased melt temperature up to a maximum dissolution rate at 820°C after which with increased temperature the iron concentration is lowered and its resistance to dissolution is increased. This phenomenon has important theoretical and practical significance since it becomes easier to understand the mechanism of the process of steel dissolution in molten aluminum. This in turn makes it possible to improve the technology of the process of molten aluminizing of steel and to effectively solve problems of increasing the durability of steel in molten aluminum. Figure 1; reference 1 (Russian).

USSR

UDC 621.774.36.016.3:539.56

STUDY OF THE CAUSES OF FRACTURE IN TUBES EXTRUDED FROM GRADE VZh-98 (EI868) ALLOY

Minsk IZVESTIYA AKADEMII NAUK BSSR, SERIYA FIZIKO-TEKHNICHESKIKH NAUK in Russian No 4, 1977 pp 30-33 manuscript received 24 Feb 77

RIZOL', A. I., LAGOSHA, A. V., TOFPENETS, R. L., DEMCHENKO, V. A., KRONFEL'D, I. D., TSAR'KOV, A. K., and SHEVCHENKO, L. I., All-Union Scientific Research Institute of Pipes, Physico-technical Institute, Academy of Sciences of the Belorussian SSR

[Abstract] A study was made to determine the causes of fracture in pipes of grade VZh-98 (EI868) alloy steel during extrusion. The initial state was found to be characterized by large agglomerations of the excess phase, a solid solution in tungsten. A complete dissolution of this excess phase occurs at the melting temperature of grain boundaries and a tungsten-nickel eutectic appears during cooling, its dispersion depending on the cooling rate. Fracture occurs where the strain is maximum, when the temperature at this

location reaches the melting point. The cause of fracture in pipes during extrusion is, essentially, the nonuniform distribution of the excess phase. Figures 3; references 3 (Russian).

USSR

UDC 621.3.038.8

STUDY OF THE DEPENDENCE OF THE PARAMETERS OF A HARDENED SURFACE ON THE ENERGY DENSITY OF LASER IRRADIATION

Minsk IZVESTIYA AKADEMII NAUK BSSR, SERIYA FIZIKO-TEKHNICHESKIKH NAUK in Russian No 4, 1977 pp 34-36 manuscript received 24 Mar 77

NAUMENKO, N. F., Mogilev Branch of the Physico-technical Institute, Academy of Sciences of the Belorussian SSR

[Abstract] A study was made to determine how the quality of a treated surface of grades 40Kh and KhVG steel, namely the surface roughness and the case depth, depends on the energy density of the irradiating laser. As the latter was increased to and beyond  $3.0 \text{ J/mm}^2$ , the surface roughness first decreased somewhat and then increased rapidly, while the case depth increased monotonically but at a steadily decreasing rate. The optimum laser flux densities were found to be  $2.0\text{-}2.2 \text{ J/mm}^2$  for grade 40Kh steel and  $2.1\text{-}2.3 \text{ J/mm}^2$  for grade KhVG steel. Figures 3; references 3 (Russian).

USSR

UDC 669.14.018.252.3:621.762.4

STUDY OF THE DEFORMABILITY OF HIGH-SPEED R6M5K5 STEEL PRODUCED BY POWDER METALLURGY METHODS

Moscow STAL' in Russian No 12, Dec 77 pp 1126-1127

OSADCHIY, A. N., KLIMENKO, A. F., and SKORNYAKOV, YU. N., Ukrainian Scientific Research Institute of Special Steels

[Abstract] The authors studied the ductility and strength properties of R6M5K5 steel in powder form and determined the optimal parameters for forging of blanks produced by hot gas-static pressing of powders. The chemical composition of the steel is as follows, %:

C	W	Mo
0.84-0.96	6.14-6.69	4.82-5.20
V	Co	O
1.92-2.20	4.99-5.26	0.021-0.048

The density of the metal in the blanks was 8.053-8.112 g/cm<sup>3</sup>. The steels produced by gas-static pressing have higher ductility properties at the temperatures used for hot pressure working than arc-melted cast metal, and can be worked using existing metallurgical plant equipment. The maximum ductility of R6M5K5 steel produced by the powder method is observed in the 1000-1130°C temperature range. The strength of the steels produced is practically identical to that of metal produced by open arc melting.

USSR

UDC 621.746.628.047

#### IMPROVEMENT OF THE QUALITY OF CONTINUOUS-CAST SLABS OF STEEL WITH HIGH RESIDUAL ALUMINUM CONTENT

Moscow STAL' in Russian No 12, Dec 77 pp 1088-1090

LEYTES, A. V., KUKARTSEV, V. M., TKACHEV, P. N., YEVTEYEV, D. P., and KLIMASHIN, P. S., Central Scientific Research Institute of Ferrous Metallurgy and Novolipetsk Metallurgical Plant

[Abstract] The Central Scientific Research Institute for Ferrous Metallurgy and the Novolipetsk Metallurgical Plant have performed studies intended to improve the quality of the surface of continuously cast large slabs of steel with 0.02-0.07% residual Al. Increasing the surface quality of slabs of steel with high residual aluminum content requires the use of slags, the physical properties of which change little upon assimilation of alumina. These slags create a lining of uniform thickness between the skin of the ingot and the walls of the crystallizer throughout the entire process of crystallization. The content of graphite in mixtures should also be reduced as much as possible. The metal must be poured into the crystallizer beneath the surface level through cups with side apertures to avoid melting of the skin of the ingot in the mid-portion of the wide faces. Mixtures containing up to 6% graphite to be poured over the surface of the melt in the crystallizers have been developed and are described. They have been used for the production of about 3 million tons of steel, with the rejection rate due to surface defects in cast slabs and sheets not over 0.21 and 0.04%, respectively. Figures 3; references 2 (Russian).

USSR

IMPROVEMENT OF THE TECHNOLOGY OF STEEL MAKING AND POURING AND IMPROVEMENT  
OF THE QUALITY OF STEEL IN OXYGEN-CONVERTER AND OPEN-HEARTH SHOPS

Moscow STAL' in Russian No 12, Dec 77 pp 1080-1086

SHNEYEROV, YA. A., TRET'YAKOV, YE. V., SMOKTIY, V. V., BOTVINSKIY, V. YA.,  
and POLYAKOV, V. F., Institute of Ferrous Metallurgy and Ministry of Ferrous  
Metallurgy, USSR

[Abstract] A Coordination Conference on Steel Making (oxygen-converter and open hearth) and the technology of pouring of carbon and low-alloy steels was held at the Institute of Ferrous Metallurgy (Dnepropetrovsk) in June of 1977. One-hundred and fifty representatives of metallurgical enterprises, scientific research and educational institutes and planning organizations took part, presenting 126 reports on the results of work performed in accordance with the coordination plans for 1976-77. An important means of increasing the effectiveness of steel making equipment is to increase the use of scrap, largely by improvement of mechanical scrap preparation methods. Reports were heard on this subject, as well as problems of expansion of the assortment of steels produced in converters; open-hearth steel making with the injection of various powdered materials into the bath; the use of dual-bath furnaces; the development of sensors for continuous measurement of the oxygen content of the metal during the finishing stages of steel making; radical improvement of steel quality by improvement of deoxidation and micro-alloying processes and the use of various methods of treatment of the metal in the ladle; pouring and improvement of the quality of carbon and low-alloy steel ingots; high-speed pouring of steel; pouring of killed steel beneath a liquid slag layer; pouring of metal shot into the mold during pouring of rimming steel; and the development of ladle gates. The conference discussed and adopted a coordination plan for scientific research work for 1978-1979.

USSR

UDC 621.746.(019+58)

STUDY OF THE STRENGTH AND DUCTILITY PROPERTIES OF STEEL THROUGH THE CROSS SECTION OF CONTINUOUS BILLETS AT HIGH TEMPERATURES

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY, CHERNAYA METALLURGIYA in Russian No 12, 1977 pp 132-135 manuscript received 5 May 76

MANGASAROV, B. N., CHIZHIKOV, A. I., KUZNETSOV, I. G., GIRSKIY, V. YE., MURASOV, F. M., and YESYUNINA, V. A., Perm' Machine Building Plant imeni Lenin

[Abstract] Studies were performed to establish the strength and ductility properties of cast and deformed metal at temperatures over 1250°C. Tensile testing was used, in an installation which heats the specimen to the required temperature and applies tension at 0.03-100 mm/s. The tests showed that the behavior of sheet steel in tension at high temperatures is different from the behavior at normal temperatures: at temperatures near the solidus, the fracture crack advances along grain boundaries. For this reason, specimens taken from the central zone of an ingot show a greater decrease in strength with increasing temperature than specimens taken from the surface zone. Figures 3; references 3 (Russian).

USSR

UDC 669-154:(541.118+536.45):532.133:620.181

ANOMALIES IN THE TEMPERATURE DEPENDENCE OF THE VISCOSITY OF LIQUID STEELS

Moscow IVUZ, CHERNAYA METALLURGIYA in Russian No 2, Feb 78 pp 29-34 manuscript received 27 Jul 77

BELOV, B. F., BORNATSKIY, I. I., NOVOKHATSKIY, I. A., KISUN'KO, V. S., and AFONIN, V. A., Donets Polytechnic Institute and Donets Physico-Technical Institute, Academy of Sciences of the Ukrainian SSR

[Abstract] The kinematic viscosity of molten metals is widely measured by the method of torsional vibrations in a crucible. Phase transformations and the concentration of aluminum (in the case of a corundum crucible) affect the solubility of oxygen in liquid iron, and jumps of the oxygen solubility in turn cause anomalies in the temperature dependence of the measured kinematic viscosity somewhere between the liquidus point and approximately 1800°C. Empirical equations describing this dependence for three typical grades of steel (St05, 20, 1Kh13) account for the fact that the inverse-exponential relation in each case changes its trend (at 1655, 1585, and 1580°C respectively). The discontinuity at these points can be interpreted in terms of the quasi-polycrystalline structural model for molten metals. Figures 1; references 17: 13 Russian, 1 German, 3 Western.

Titanium

USSR

UDC 669.2

THE POSSIBLE CAUSE OF SEASONAL DETERIORATION IN THE QUALITY OF SPONGE TITANIUM

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY, TSVETNAYA METALLURGIYA  
in Russian No 1, 1978 pp 144-145 manuscript received 9 Mar 77

KECHIN, V. A., VYATKIN, I. P., MUSHKOV, S. V., and BRANDMAN, O. I., Northern Caucasus Mining and Metallurgical Institute; Bereznikovskiy Titanium-Magnesium Combine

[Abstract] The quality of titanium sponge produced by the magnesium-thermal method decreases during the summer, as a result of a number of factors, particularly the influence of increased humidity on the quality of titanium tetrachloride and changes in the quality of the magnesium used as a titanium tetrachloride reducer. The content of hydrogen and nonmetallic oxide inclusions in electrolytic magnesium changes significantly as a function of the absolute moisture content of the air. The influence of magnesium quality is confirmed by the time lag from a sudden increase in humidity to a corresponding decrease in titanium sponge quality--10-12 days, the time from the beginning of the process of reduction to output of a batch of finished titanium sponge.

USSR

UDC 539.3:620.17:669.295.5

UTILIZATION OF AN EXPONENTIAL STRENGTHENING RULE TO ANALYZE THE PROCESS OF STRENGTHENING OF TITANIUM ALLOYS WITH VARIOUS DEGREES OF STABILITY

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 78 pp 83-86 manuscript received 10 Nov 76

PAVLOV, I. M., PANOVKO, V. M., and TARASEVICH, YU. F., Institute of Metallurgy imeni A. A. Baykov, Academy of Sciences USSR

[Abstract] This article continues a discussion on the possibility of using the equation  $S=A\varepsilon^n$ , where  $S$  is the true stress,  $\varepsilon$  is the true strain,  $n$  is the hardening index and  $A$  is the strength coefficient, to describe the process of hardening of polycrystals. The change in parameter  $n$  upon deformation of metastable materials may indicate a change in the quantity of a phase which forms or decomposes per unit time. A change in the conditions of relaxation upon deformation of decomposing alloys (for example, due to temperature and velocity), may significantly increase the plasticity of the alloy to quantities characteristic for superplasticity. The independence of the parameters  $n$  and  $\varepsilon_b$  for a greatly work-hardened metal may mean that the

condition  $dS/d\varepsilon S$  is not fulfilled, even during the initial moment of extension, due to the significant increase in the value of S and the decrease in  $dS/d\varepsilon$  during preliminary deformation. Figures 2; references 10: 3 Russian, 7 Western.

USSR

UDC 669.295'24'25

INFLUENCE OF ALLOYING ON THE TEMPERATURE OF APPEARANCE OF SHAPE "MEMORY" IN TITANIUM NIKELIDE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2, 1978 pp 72-73

CHERNOV, D. B., MURZOV, D. A., BELOUSOV, O. K., Institute of Metallurgy imeni A. A. Baykov

[Abstract] Results are presented from studies of the influence of deformation and composition on the critical point of martensitic conversion in specimens of alloys of the trinary systems Ti-Ni-Fe and Ti-Ni-Co. The iron and cobalt content was not over 3.5 at. %. The tests were performed on an installation allowing compressive deformation at liquid-nitrogen temperatures. It is found that restoration of the shape of an alloy containing 2 at .% Fe or 3.5-4 at.% Co can be achieved by cooling it (for example, in liquid nitrogen) and deforming it at this temperature. When it is subsequently warmed to -120°C, the restoration process begins, and is completed by -80°C. The stresses arising in the process of recovery at low temperatures may reach 50-60 kg/mm<sup>2</sup>, allowing the creation of products capable of carrying significant loads. Figures 2; references 2: 1 Russian, 1 Western.

USSR

UDC 669.2

STUDY OF PROPERTIES OF SPONGE TITANIUM FOR PURPOSES OF PHOTOMETRIC SORTING

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY, TSVETNAYA METALLURGIYA  
in Russian No 1, 1978 pp 63-66 manuscript received 11 Aug 76

KOZIN, V. Z., TSYPIN, YE. F., PROKHOROV, G. A., SHIRYAYEV, R. YE., and  
LIKHTERMAN, V. A., Bereznikovskiy Titanium-Magnesium Combine

[Abstract] An estimate is presented of the possibility of photometric sorting of titanium with the purpose of eliminating defective lumps which are colored differently, so as to reduce manual labor in the sorting section. Spectrophotometric studies of a batch of sponge titanium from one enterprise were performed with a particle size of 20-50 mm using an SF-14 spectrophotometer in two stages. The first stage involved measurement of the diffuse reflection spectra of individual specimens, the second--measurement of the coefficients of reflection of lumps of different batches of titanium at a fixed radiation wavelength. The studies indicate that individual low-grade varieties of sponge titanium have significantly different reflective properties than the commercial product, allowing partial separation by photometric means. Figures 2.

USSR

UDC 669.295'28:539.32

MODULUS OF ELASTICITY IN Ti-Mo ALLOYS AT LOW TEMPERATURES

Moscow IAN SSSR, METALLY in Russian No 2, Mar/Apr 78 pp 214-216 manuscript  
received 27 Dec 76

KIM, P. T., NOVIKOV, I. I., and PROSKURIN, V. B., Moscow

[Abstract] Young's modulus, shear modulus and Poisson ratio were determined for Ti-Mo alloys at 80-300°K. The dynamic properties of 11 Ti-Mo alloys, with an Mo concentration ranging from 0.1 to 40 wt%, were studied. The complex nature of the concentration relationship of the modulus of elasticity is explained by the change in alloy phase composition. Analysis of Ti-Mo phase diagrams showed that the alpha'-phase is fixed at Mo concentrations of 0.7-0.8 wt%. Above this concentration the beta-phase develops and at 5-10 wt% Mo the sigma-phase is observed. This phase composition is characteristic for this system at short heating times and an annealing temperature of 800°K. Small quantities of Mo (alpha'-region) deform the HCP lattice of alpha-titanium which decreases the modulus of elasticity. Appearance of the beta-phase also leads to the same decrease. The increase in the modulus of elasticity in the region of 5-10% Mo probably is responsible for sigma-phase development.

Later, the increase in beta-phase content leads to large distortions of the HCP lattice and a noticeable development of the weaker BCC structure resulting in a decrease in the modulus of elasticity. At Mo concentrations higher than 20% only the beta-phase exists and a rise in the modulus occurs due to the increase in Mo contribution to the forces of interatomic mutual action in the BCC lattice. Thus, the existence of two metastable regions whose phase composition is very sensitive to heat treatment modes is the reason for intense changes to the modulus of elasticity in Ti-Mo alloys with an Mo content of 5-30%. V. S. MIKHEYEV provided assistance in the selection of alloy composition. Figures 4; references 5: 4 Russian, 1 Western.

USSR

UDC 669.017

STUDY OF HETEROGENEITY OF THE COMPOSITION, STRUCTURE AND PROPERTIES OF INGOTS OF TITANIUM AND ITS ALLOYS

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY, TSVETNAYA METALLURGIYA in Russian No 1, 1978 pp 110-113 manuscript received 15 Apr 77

KOLACHEV, B. A., KUZNETSOV, K. I., GRISHIN, V. A., STRUYEV, I. I., and SIMONCHUK, A. D., Moscow Aviation Technology Institute, Department of Metallurgy and Hot Working of Metals; Stupinskiy Metallurgical Combine

[Abstract] Specimens from different parts of a single ingot of VT-1 titanium and other titanium alloys of practically identical composition have significantly different strength and ductility. To discover the nature of this phenomenon--the chemical heterogeneity through the height and cross section of ingots of these alloys--the nature of the structure and peculiarities of crystallization of the ingots were analyzed. There are at least two mechanisms tending to cause uneven distribution of the elements through the length of the ingot: zonal distribution and "dilution" of the liquid zone. The effects of these processes may either be added or subtracted. In VT-1, VT-5 and AT-6 ingots, the distribution of mechanical properties through the height and cross section of the ingots depends on the distribution of the alloying elements and impurities in the volume of the ingot. Figures 2; references 3 (Russian).

USSR

UDC 621.794.44:541.4-143-38/:519:65.012.2

OXIDIZING ALKALINE MELTS FOR THE REMOVAL OF SCALE FROM TITANIUM

Moscow ZASHCHITA METALLOV in Russian Vol 14 No 2, Mar/Apr 78 pp 183-186  
manuscript received 5 Jan 77

VYDRA, E. I., NAUMENKO, G. N., KOVALENKO, A. K., BOGOMAZOVA, YE. S., and NOZDRACHEV, A. V., All-Union Scientific Research and Design-Technology Institute of the Pipe Industry

[Abstract] This work evaluates the effect of components of an oxidizing alkaline solution during etching of specimens of VT-1 measuring 30x20x1 mm. The optimization parameters were the clarification time in an acid solution and the corrosion of the metal in the melt. Regression equations are produced which describe the process. The mechanism of etching of titanium in the oxidizing melt is found to depend on the temperature of the melt. At low temperatures, sodium nitrate and nitrite act as inhibitors, repassivating the exposed metal. Sodium peroxide and sodium fluoride accelerate the scale removal process. At high temperatures, sodium nitrite and nitrate not only etch the metal, but may also cause combustion; in this case  $TiO_2$  acts as an inhibitor. The influence of water is ambiguous as concerns the corrosion activity of an NaOH melt: It depends on many factors and is different for each case. Figure 1; references 3 (Russian).

USSR

UDC 669.295:539.4.011

EFFECT OF HEAT TREATMENT ON THE NATURE OF FRACTURE IN VT23 TITANIUM ALLOY

Moscow IAN SSSR, METALLY in Russian No 2, Mar/Apr 78 pp 151-154 manuscript  
received 21 Jan 76

SHISHKINA, M. I. and TOMSINSKIY, V. S., Perm

[Abstract] Samples of VT23 titanium alloy were cut from sheet, heated and quenched from 775, 800, 825 and 875°C. Then samples from each quenched batch were aged at 400, 450, 500 and 550°C for 10 hours. With increased quench temperature, alloy strength increases while ductility and impact strength decrease. The optimum combination of mechanical properties is obtained following quenching at 825°C and aging at 500°C. Microfractograms of alloy fractures showed that in the quenched and annealed states the fracture surface has a pitted structure and the higher the quench temperature the larger the pit dimensions. After aging the fracture structure changes from "quasi-shear" at 400° to pitted at 550°, which was associated with decomposition of metastable phases and coalescence of the decomposition products. Two factors are

given for the increase in pit size: 1) increase in the length of alpha''-needles and dissolution of fine grains of the primary alpha-phase, and 2) an increase in the distance between the needles and alpha-phase grains. Figures 2; references 1 (Russian).

USSR

UDC 669.295:620.251.1:620.181.1

KINETICS OF METASTABLE BETA-PHASE DECOMPOSITION IN VT9 TITANIUM ALLOY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 45 No 2, Feb 78  
pp 354-359 manuscript received 8 Apr 77

D'YAKOVA, M. A., POTEVKINA, T. G. and MAKHNEV, YE. S., Ural Polytechnical Institute imeni S. M. Kirov

[Abstract] Diagrams of the isothermal decomposition of the beta solid solution in VT9, supercooled from 920°C, were plotted and the effect of phase transformation occurring on mechanical properties and modulus of elasticity was investigated. At temperatures above  $M_s$  the decomposition of the beta solid solution proceeds with formation of the alpha-phase. After isothermal soaking at 400-500° a large quantity of mechanically unstable beta-phase is fixed, decomposing with formation of strained martensite. The formation and decomposition of alpha''-martensite with precipitation of dispersed beta-phase particles occurs at supercooling temperatures below  $M_s$ . With lowering of the supercooling temperature the process of martensite decomposition is slowed and in the same temperature interval the decomposition of supercooled beta-phase by an intermediate transformation can be observed with an increase in soaking time. Short isothermal soaks at 100° stabilize the beta solid solution with respect to the formation of cooled martensite. Decomposition of alpha''-martensite and decomposition of metastable beta-phase at the supercooling temperatures (200-350°) leads to increased strength and reduced ductility. Decomposition of the beta-solid solution at 550-650° with formation of the alpha-phase increases yield and tensile strengths and preserves ductility at an adequate level. Figures 4; references 6: 4 Russian, 2 Western.

USSR

UDC 669.295:536.42

INVESTIGATION OF ALPHA''-MARTENSITE DECOMPOSITION DURING CONTINUOUS HEATING  
OF VT16 TITANIUM ALLOY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 45 No 2, Feb 78  
pp 426-428 manuscript received 22 Feb 77

MAL'TSEV, M. V. and KASHNIKOV, N. I., Gor'kiy Polytechnical Institute imeni  
A. A. Zhdanov

[Abstract] Samples of VT16 titanium alloy were quenched from 815°C to an alpha + alpha'' structure and slowly heated (3°/min) to 150-600°C with a sample quenched every 25°. X-ray and dilatometric analyses as well as hardness and mechanical property measurements were conducted with the samples under tension. X-ray analysis established the decomposition of alpha''-martensite into alpha- and beta-phases of equilibrium composition with almost no volume change. Strength and hardness started increasing above 300°, reaching a maximum at 525-550°C. It was noted that upon heating to a temperature below 350°C, but above that which the alpha''-martensite decomposition was observed, small quantities of beta-phase were detected. It was assumed that the heterogeneous alpha''-martensite is enriched with alloying elements to a composition for which the temperature of the reversible alpha''--beta transformation is somewhat below 350°C. This assumption was based on the possibility of the transformation to the beta-phase being diffusionless during heating to 150-175°C and the fact that with increased quench temperature, resulting in a decreased content of alloying elements in the alpha''-martensite, the temperature of the transformation is elevated and the amount of transformed alpha''-martensite becomes less. Measurement of the lattice periods of the two phases showed that the specific volume of alpha''-martensite is greater than that of the beta-phase and therefore the phase cold work is absent as a result of the diffusionless transformation and the transformation itself does not lead to a substantial increase in alloy strength. Figures 2; references 3 (Russian).

Welding

USSR

ON THE QUESTION OF ALLOYING DEPTH IN ION-BEAM WELDING

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 239 No 3, 21 Mar 78 pp 576-578 manuscript received 26 Dec 77

PATON, B. YE., Academician, GABOVICH, M. D., NAZARENKO, O. K., PORITSKIY, V. YA. and PROTSENKO, I. M., Institute of Electric Welding imeni Ye. O. Paton

[Abstract] Experiments were conducted into ion-beam welding to determine alloying depth achievable by this method. Using ion fluxes with a current density of more than  $10 \text{ A/cm}^2$  and specific energy greater than  $10^4 \text{ w/cm}^2$ , titanium and steel several millimeters thick were joined where the seam was simultaneously alloyed with impurities in an amount sufficient to noticeably alter the physical and technical properties of the seam. In another test titanium iodide was welded with carbon ion beams extracted from the discharge plasma of  $\text{CO}_2$ . Change in microhardness of the weld seam was due to the introduction of carbon whereas when argon ions were used there was no change noted in microhardness. A feature of ion-beam welding is that atoms of the material being welded are vaporized to become a part of the plasma and are subsequently returned to the metal to preserve its composition so that the welding process is done not only by ions of the introduced gas but also by the ions of the welded metal. Results of this study are the first evidence of the possibility of alloying the seam by ion-beam welding. Further studies will be required to develop methods to increase current density and specific energy of ion beams of different elements and to study the structure of composites produced by introducing large fluxes of impurity atoms as well as the properties of these composites. Figures 2; references 4: 3 Russian, 1 Western.

USSR

UDC 621.791.011

STUDY OF THE WELDING PROPERTIES OF ALLOYS SUCH AS AMg6 CONTAINING TRANSITION GROUP ELEMENTS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 2, Feb 78 pp 20-24 manuscript received 21 Jun 77 after revision

SAYENKO, M. I., FORTUNATOVA, N. N., SHVETS, N. P., Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences Ukrainian SSR; KAZACHINSKAYA, N. V., Kiev Polytechnical Institute, and VASIL'YEVA, G. B., All-Union Institute of Light Alloys

[Abstract] The influence of variations in the content of silicon, iron and transition metals (chromium, zirconium, titanium) on the mechanical properties of the base metal and welded joints in AMg6 alloy was studied using the method of mathematical planning of experiments. A change in the content of

iron and silicon in AMg6 provides for the most effective control of the mechanical properties of the base metal and of welded joints. A change in the quantity of zirconium and chromium is also rather effective in its influence on the properties of AMg6; the influence of titanium is somewhat less. The best combination of strength and plasticity of the base metal and welded joints is provided by the aluminum alloy containing 6.2% Mg, 0.05% Fe, 0.03% Si, 0.2% Zr, 0.2% Cr, 0.05% Ti and 0.3% Mn. Figure 1; references 7 (Russian).

USSR

UDC 621.791.755

AN INCREASE IN THE PRODUCTIVITY OF AUTOMATIC MICROPLASMA WELDING OF VERY THINWALL PIPE

Kiev AVTOMATICHESKAYA SVARKA in Russian No 2, Feb 78 pp 42-43 manuscript received 12 Apr 76

VERBITSKIY, V. G., ARDASHIROV, N. SH., TULUPOV, V. P., Ufa Aviation Institute, DUDKO, D. A., SHNAYDER, B. I., and GODLIS, YU. YE., Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences Ukrainian SSR

[Abstract] A study is made of the possibility of increasing the productivity of automatic microplasma welding of thinwall pipe. Experiments were performed on an experimental installation welding pipe measuring  $8.8 \times 0.2$  mm made of 12Kh18N10T strip, with MPU-4 and IPSD-200 power supplies. A low-ampere compressed arc was used to improve the formation of the seam while increasing the speed of welding. The plasma-forming gas used was argon; the protective gas was argon plus 7% H<sub>2</sub>. The studies showed that the productivity of the process of automatic microplasma welding of very thinwall pipe can be increased by eliminating vibration of the installation as welding speed is increased; by placing more rigid requirements on the accuracy of assembly and guiding of the edges of the skelp with respect to the plasmotron; by facilitating checking and adjustment of the position of the plasmotron relative to the joint; by improving the operational characteristics of the plasmotron for long-term operation; and by increasing the power supply. Figures 3.

USSR

UDC 621.791.4:539.38.3

EFFECT OF A VACUUM ON JOINT FORMATION IN THE DIFFUSION WELDING OF TITANIUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 3, Mar 78 pp 54-56 and 62 manuscrpt received

KOTEL'NIKOV, A. A., Candidate of Technical Science, and BASHURIN, A. V., POPOV, YU. A. and SHMYGAREV, A. G., Engineers, Kursk Polytechnical Institute

[Abstract] The effect of a vacuum medium on formation of joints without defects was studied by diffusion welding VT3-1, VT5-1 and VT15 titanium alloys with a different initial structure. Samples 16 mm in diameter and 30 mm long were welded in a vacuum of  $1.2-2 \times 10^{-4}$  mm Hg on an SDVU-3K unit with an oil means of pump out and on a unit with oilless means of pump out with a TMN-200 turbomolecular pump. When VT3-1 alloy is welded at 1050°C the samples experience significant grain growth, but at 850° there are no defects and the initial structure is preserved. When welded in the vacuum chamber, using samples previously heated to dry them out, with the oil pump out, globular defects can be detected which are the result of moisture on the sample surface and in the chamber and the presence of carbon-containing compounds on the joined surfaces and in the protective medium. Single-phase VT5-1 and VT15 alloys revealed a similar relationship of pore sizes to temperature and even after a lengthy soaking VT5-1 alloy still contains pores while at the same time pores do not form in two-phase alloys, which is explained by the difference in the nature of hydrogen distribution in the one- and two-phase alloys. The best method of welding these titanium alloys is to use the turbomolecular pump and to heat the chamber and samples to dry them out. Optimum temperature for welding is 850°C. This temperature retards grain growth and prevents any sharp change in the solubility of hydrogen in the alloys. Figures 4; references 6: 5 Russian, 1 Western.

USSR

UDC 621.791.753.5

SEAM POROSITY AND DISTRIBUTION OF GAS IMPURITIES ACCORDING TO FLUX IN THE ARGON-ARC WELDING OF TITANIUM

Kiev AVTOMATICHESKAYA SVARKA in Russian No 3, Mar 78 pp 30-33 manuscript received 24 Jun 76

SMIYAN, O. D. and ZAMKOV, V. N., Candidates of Technical Sciences, Institute of Electric Welding imeni Ye. O. Paton

[Abstract] VT-1-0 technical titanium, five millimeters thick, was argon-arc welded with a tungsten electrode using ANT-17-A, FAN-1 and ANT-23-A fluxes. Welding speeds varied from five to 80 m/hr. The first two fluxes mentioned prevent pore formation over the entire range of welding speeds. ANT-23-A flux has the lowest effectiveness of preventing pore formation since it contains  $\text{AlF}_3$ , which sublimates at lower temperatures than the components of the other two fluxes. ANT-17-A flux exhibited the smallest distribution of hydrogen except at 80 m hr. The melting activity of ANT-17-A and FAN-1 fluxes was analogous except at a welding rate of 5 m hr where FAN-1 was less active. One feature of FAN-1 flux is that it removes oxygen from the welded metal. Figures 4; references 8: 7 Russian, 1 Western.

USSR

UDC 621.791.76:621.7.044.2:621.785.735

FEATURES OF THE FORMATION OF RESIDUAL STRESSES DURING EXPLOSIVE WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 78 pp 10-12

POKATAYEV, YE. P., Candidate of Technical Sciences, and TRYKOV, YU. P., Candidate of Technical Sciences, Volgograd Polytechnical Institute

[Abstract] Analysis of the process of explosive welding indicates the following possible causes for the formation of heterogeneous plastic deformations and residual stresses: compound bending of the flying plate; intensive plastic deformation of the metal; elastic-plastic bending of the welded plates; and thermoplastic deformation due to uneven heating. The significance of each of these factors in the formation of residual stresses was estimated by analysis of six series of experiments. The analysis showed that high residual tensile stresses in the metal results primarily from elastic-plastic deformations due to uneven heating and overall bending of the welded plates. When dissimilar materials are joined, the difference in their properties is manifested as a displacement of the area of tensile stresses into the material with the lower heat conductivity. Figures 8; references 9 (Russian).

Miscellaneous

USSR

UDC 669.017.3

EFFECT OF DEFORMATION ON THE MECHANISM OF GAMMA'-PHASE PRECIPITATION IN A NICKEL-ALUMINUM-TITANIUM ALLOY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 45 No 2, Feb 78  
pp 436-440 manuscript received 3 May 77

SUKHAROV, V. F. and SEREGIN, G. V., Siberian Physico-Technical Institute

[Abstract] The effect of plastic deformation on the process of continuous gamma'-phase precipitation in a simple-structured Ni-6% Al-1% Ti alloy was studied. Samples of the alloy were soaked for one hour at 1050°C in a vacuum of  $10^{-2}$  torr, quenched in salt water, rolled to reductions of 0, 15, 30, 50, 80 and 90% and aged at 300, 450, 550, 650, 750, 850 and 950°C for 100 hours. Reductions of 30% or more breaks up the gamma' particles formed during quenching, causing them to disappear from electronograms. However, by tempering at 300°C the gamma' particles form in all the samples by means of migration of deformed point defects which cause the initial stages of decomposition at higher temperatures, and recrystallization nuclei do not form in this stage. At 550 and 650° continuous gamma'-phase precipitation starts sluggishly and stops very soon. The continuous precipitation reaction does not occur and gamma'-phase precipitation takes place only by the mechanism of continuous decomposition; cold working is preserved. At 350 and 450° the gamma'-phase is not formed. In those instances when recrystallization nuclei form the gamma' particles are dissolved to form a supersaturated solid solution. It was concluded that in the Ni-Al-Ti alloy, deformed and tempered at 300-950°, the discontinuous reaction of precipitation does not coarsen gamma'-phase particles prior to their continuous precipitation or in the process of recrystallization or after recrystallization. Figures 6; references 15: 5 Russian, 10 Western.

USSR

UDC 669.15'24'295:669.017.3

ON THE MECHANISM OF AGING IRON-NICKEL-TITANIUM ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 45 No 2, Feb 78  
pp 377-384 manuscript received 22 Jul 77

VINTAYKIN, YE. Z., DMITRIYEV, V. B. and UDOVENKO, V. A., Institute of Physical Metallurgy and Metal Physics, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] A neutronographic study was made of the structural changes in the initial stages of aging Fe-Ni-Ti alloys for the purpose of finding the phase transformation mechanism in their structure. Five alloys were studied where Ni content varied from 26.21 to 29.25 at. % and Ti content--from 2.50 to 5.75 at. %. The initial states of samples (rod and single crystals) was established by annealing at 1200°C for two hours and water quenching. After heat treating and neutron exposure it was observed that the nuclei of the fcc gamma'-phase in Ni<sub>3</sub>Ti are ordered by Cu<sub>3</sub>Au regions which do not differ from the gamma-matrix in composition. These nuclei form in the earliest stages at 550° and their rate of formation is a function of Ti content. At a Ti content greater than 3 at. % these nuclei even form during quenching. With increasing aging time there is a change in concentration inside the nuclei along with growth and appearance of true gamma'-phase precipitations in alloys with a high Ti content. For low-Ti alloys depletion of the matrix of nickel is less and diffusion formation of the alpha-phase does not occur even after aging for 100 hours although the martensite transformation in it is fully suppressed after heat treatment. Figures 6; references 14: 9 Russian, 5 Western.

USSR

UDC 537.312.62:669.27/29

EFFECT OF ZIRCONIUM ALLOYING ON THE ANISOTROPY OF CRITICAL CURRENTS IN DIFFUSION Nb<sub>3</sub>Sn STRIP

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 45 No 2, Feb 78  
pp 269-277 manuscript received 30 Mar 77

SAVITSKIY, YE. M., POLAK, M. and MIKHAYLOV, B. P., Institute of Metallurgy imeni A. A. Baykov, Academy of Sciences USSR and the Electrotechnical Institute, Slovakian Academy of Sciences Czechoslovakia

[Abstract] Alloying a niobium substrate with small additions of zirconium (1.14-1.90% by weight) was investigated to determine their effect on structure, current-conducting properties and critical current anisotropy of Nb<sub>3</sub>Sn strip produced by diffusion in tin baths with 40 and 30 at. % Cu. The strip was hot forged at 1,000°C and cold rolled to reduce the 5-mm-thick strip to 1 mm. Further rolling to reduce the strip to a thickness of 80-100 microns was done on a six-roll mill at the experimental plant in Karlsstein, Czechoslovakia. The Nb<sub>3</sub>Sn foil was heat treated at 890°C for 20 and 40 minutes and at 880° for 30 minutes. The critical current decreased with increased heating time for all samples and was accompanied by grain elongation which led to intensification of critical current anisotropy. Foil with 1.53 and 1.70% Zr had the highest critical current values. Microhardness of samples with 1.53 and 1.70% Zr increased with longer heating times but there was no change in the hardness of foil with 1.14 and 1.90% Zr. The high critical currents in substrates with 1.53 and 1.70% Zr are explained by the formation of ZrO<sub>2</sub> particles of optimum size while with 1.90% Zr the oxygen concentration is increased and creates favorable conditions for ZrO<sub>2</sub> coalescence, coarsened Nb<sub>3</sub>Sn grains and lowered critical current. The relationship of the coefficient of anisotropy to magnetic field magnitude shows that there is little dependence on field magnitude. The coefficient increases with increased Zr concentration. Increase in anisotropy coefficient with increased annealing time can be associated with elongation of Nb<sub>3</sub>Sn grains which causes a lower critical current density. The authors thanked I. GLASNIK, YA. KRUZHLYAK and S. TAKACH for helpful discussions and YA. ANDRIK for performing the electron microscope work. Figures 8; references 11: 5 Russian, 6 Western.

USSR

UDC 669-132:621.785.7:(669.295+669.71)

ROLE OF TITANIUM AND ALUMINUM IN ESTABLISHING THE ELASTIC LIMIT OF AUSTENITIC IRON-NICKEL ALLOYS

Moscow IVUZ, CHERNAYA METALLURGIYA in Russian No 2, Feb 78 pp 106-109 manuscript received 16 Nov 76

KHOMENKO, O. A., SAZYKINA, A. V., and ZVIGINTSEVA, G. YE., Ural Polytechnic Institute

[Abstract] A study was made to determine the role of titanium alone and of titanium together with aluminum on the apparent elastic limit of dispersion-hardening austenitic iron-nickel alloys. Three groups of alloys were involved in this experiment: 1) Fe-Ni alloys with 1.1-3.5% Ti, 2) Fe-Ni alloys with 2.3% Ti and 0.6-2.8% Al, and 3) Fe-Ni alloys with 5% Cr and 1.6-3.9% Ti. Tape specimens were, prior to testing, either annealed at 400-800°C for 6 hours (thermomechanical treatment) or quenched from 1050°C with a subsequent temper (dual heat treatment). Both elements together were found to raise the elastic limit most appreciably after preliminary plastic deformation followed by a low-temperature temper (400-500°C). Each element alone was found to raise the elastic limit of quenched tape after a temper at 600°C. Aluminum is much more effective in increasing the resistance of thermomechanically treated alloys against microplastic deformation. Addition of chromium does not, in principle, alter the role of both elements. Figures 3; references 5: 4 Russian, 1 Western.

USSR

UDC 669.112.227

MAGNETOMETRIC ANALYSIS OF PHASE TRANSFORMATIONS IN UNSTABLE AUSTENITIC Fe-Ni-C ALLOYS

Moscow IVUZ, CHERNAYA METALLURGIYA in Russian No 2, Feb 78 pp 99-102 manuscript received 6 Aug 76

APAYEV, B. A., VORONENKO, B. I., ROMATOVSKIY, YU. I., and KHMETSHIN, SH. KH., Physico-Technical Research Institute at Gorkiy State University

[Abstract] The kinetics of forward and reverse martensite transformations as well as structural and magnetic properties of unstable austenitic cast alloys, after annealing at 1000°C for 4 hours (to ensure more thorough graphitization) and air cooling, were measured with two magnetometers. Six groups of alloys were involved in this experiment: 1) 1.75-2.34% C with a variable silicon content (1.6-4.5%), 2) 1.9-2.03% C with a variable manganese content (0.3-9.8%), 3) 1.9-2.03% C with a variable copper content (2.6-10.2%), 4) 1.9-2.03% C with a variable chromium content (1.0-4.6%), 5) 1.9-2.03% C with a variable

molybdenum content (0.90-3.00%), and 6) 1.9-2.03% C with a variable nickel content (10.4-21.2%). Thermomagnetic characteristics, namely the temperature dependence of the saturation magnetization and the dependence of the martensite transformation temperature on the concentration of a given alloying element, were obtained from test data. Figures 3; reference 1 (Russian).

USSR

UDC 669.018.44.45:621.78.08

EFFECT OF HEAT TREATMENT ON THE INTERNAL FRICTION IN A CAST NICKEL-CHROMIUM ALLOY

Moscow IVUZ, CHERNAYA METALLURGIYA in Russian No 2, Feb 78 pp 96-98 manuscript received 29 Jul 77

GADALOV, V. N., NOVICHKOV, P. V. (deceased), NAGIN, A. S., and ANTIPOV, V. A., Voronezh Polytechnic Institute

[Abstract] A study was made to determine the effect of heat treatment on internal friction and relaxation in the heat-resistant cast nickel-chromium alloy containing 61.1% Ni + 19.6% Cr + 9.8% Fe + 5.2% Mo + 2.8% Ti + 1.4% Al + 0.05% C. The internal friction was measured, within a 3% accuracy, over the temperature range from 20 to 900°C: first in the initial state and then after quenching from various temperatures. The effect of the treatment temperature (1100-1250°C) and of the cooling rate (air or water quenching) on the temperature dependence of the internal friction was also determined. The anomalous relaxation peak at 300°C is attributed to a concurrence of two processes: migration of carbon atoms and interaction of interstitial atoms with split dislocations. There also appear one peak at room temperature, two peaks within the 400-600°C range, which decrease after aging, and a high peak within the 700-750°C range characterizing the mobility of atoms at grain boundaries in a stress field. Figures 3; references 9: 8 Russian, 1 Western.

PRIMARY RECRYSTALLIZATION OF CuNi<sub>10</sub> ALLOY UNDER CONDITIONS OF RAPID CONTINUOUS HEATING

Minsk IZVESTIYA AKADEMII NAUK BSSR, SERIYA FIZIKO-TEKHNICHESKIKH NAUK in Russian No 1, 1978 pp 47-51 manuscript received 5 Apr 77

KRUPKOVSKIY, A., BODYAKO, M. N., VEZHBIN'SKI, S. and YAROSHEVICH, G. B., Institute of Metallurgy Foundations, Polish Academy of Sciences, Krakow, and the Physical-Technical Institute BSSR

[Abstract] The mechanical properties of CuNi<sub>10</sub> alloy with a varying degree of deformation were studied after the alloy had been subjected to recrystallization annealing at a rapid heating rate. Rods of CuNi<sub>10</sub> alloy, 13.6 mm in diameter, were produced by hot deformation (32, 60 and 75%) at 850-950°C, drawn to a diameter of 10 mm after cooling, and recrystallized at 700°C for three hours. Samples of the rod were heated at rates of 25 and 250 deg/sec from which it was found that the increased heating rate shifts the primary crystallization temperature into a region of higher temperatures while at the same time the increased degree of deformation causes the opposite effect. Samples deformed at 60% and heated at 25 deg/sec underwent full recrystallization in the 680-760°C interval while at the rate of 250 deg/sec the interval was 700-780°C. Samples deformed at 75% and heated at 25 deg/sec recrystallized at temperatures 660-760°C and at the rate of 250 deg/sec--680-780°C. These data show that for a given degree of deformation the temperature interval for the start and end of recrystallization was constant and independent of heating rate. It was also found that the change of mechanical properties in the stage of anisothermal recrystallization is an order higher than the change corresponding to the stage of anisothermal recovery, and the change in values of the mechanical properties spreads farther apart with increased degree of deformation. The difference in strength properties of fully recrystallized samples, previously deformed to the same degree and then heated at different rates, was caused by the difference in average grain size which is finer for the faster heating rate. Ductility of the material depends on the manner in which the grain was produced. Rapid heating rates are the cause of formation of completely different dislocation structures inside the grains themselves in comparison with a grain of the same order produced under conditions of isothermal recrystallization. Figures 2; references 5 (Russian).

USSR

UDC 669.14.018.54

DEOXIDATION AND ALLOYING OF MAGNETICALLY HARD ALNICO ALLOYS WITH ALUMINUM AND TITANIUM

Moscow IAN SSSR, METALLY in Russian No 2, Mar/Apr 78 pp 54-59 manuscript received 13 Oct 76

KUZNETSOV, V. M., LOBYNTSEV, YE. S., FEDOTOV, V. P. and BELYAYEVA, V. I., Moscow

[Abstract] Alnico alloys with a nominal composition of 64% Fe, 16% Co, 17% Ni, 3% Cu and small amounts of Al and Ti were made for the purpose of determining the effect of Al and Ti as deoxidizers as well as their effect on the structure and magnetic properties of these alloys. Tests showed that at 1600°C, despite the fact that Al is a stronger deoxidizer than Ti, the addition of Ti leads to a reduced oxygen content. Study of nonmetallic inclusions in the alloys containing 0.1-1.68% Ti revealed the presence of Al and Ti oxides as well as Ti nitrides. The deoxidizing capability of Al and Ti in alnico is greater than the deoxidizing capability of each taken individually. The oxygen in these alloys is dissolved in octohedral pores. With increased pore size the quantity of oxygen increases. When alloyed with Ti the lattice parameters of the alloy structure begin increasing when Ti content reaches 0.7-0.8%, which is one of the reasons for increased oxygen content. According to experimental and computed data the Ti concentration in Fe is 1.0-1.1% at a minimum oxygen concentration. However, the minimum quantity of oxygen in these alloys exceeds the minimum content of oxygen in Fe and is a result of the following phenomena: 1) change in oxygen activity; 2) change in Ti and Al activity; and 3) the possibility that no metal-oxide phase-gas phase equilibria has been achieved. The lowering of residual induction values with increased Ti content is explained by the decrease in magnetization saturation and refinement of primary grains or the nonmetallic Ti inclusions whose melting point is above that of the alloy's solidification temperature and provide additional crystallization centers which also refine the grain structure. The unoriented direction of easy magnetization in neighboring grains leads to formation of closed magnetic loops inside the material with a corresponding loss of useful magnetic induction. Study of the microstructure and magneto-metric data showed that the alpha solid solution is stabilized when alloyed with Ti. Here the upper temperature boundary of "highly coercive" decomposition for the alpha--alpha + alpha' transformation upon alloying with 1% Ti is shifted from 870° to 830°C. The mechanical properties of magnetically hard Fe-Co-Ni-Al alloys increase when alloyed with Ti:  $H_v$  increases from 520-530 to 600 kg/mm<sup>2</sup> and compressive strength--from 10,260 to 12,000 kg/cm<sup>2</sup>. Alloying with Nb, Si and Ti produces an alloy with reduced cobalt content--15% instead of 18%. This alloy can be used instead of alloy YuNDK18 when magnetic properties are essential. Figures 2; references 19: 13 Russian, 6 Western.

USSR

PROBLEM OF RADIATION DAMAGE OF MATERIALS IN CONJUNCTION WITH DEVELOPMENT OF ATOMIC AND THERMONUCLEAR POWER ENGINEERING

Alma-Ata VESTNIK AKADEMII NAUK KAZAKHSKOY SSR in Russian No 11, Nov 77 pp 55-67

IBRAGIMOV, SH. SH., Academician, Academy of Sciences Kazakh SSR

[Abstract] This report was read to a session of the general assembly of the Academy of Sciences Kazakh SSR on 6 Apr 77. The effect of radiation damage in the materials which comprise the elements of atomic and thermonuclear energy stations is collectively examined from various literature sources. In stainless steels of the Kh18N9 type the most intensive change of properties results from integral neutron fluxes below  $10^{20}$  N/cm<sup>2</sup> and as the flux increases, producing an irradiation dose of almost  $2 \times 10^{22}$  N/cm<sup>2</sup>, yield strength increases 2.5 times and 300-degree ductility diminishes by four times. Niobium in the VVR-K reactor at the Institute of Nuclear Physics, Academy of Sciences Kazakh SSR, having received a dose of  $4 \times 10^{21}$  N/cm<sup>2</sup>, had its yield strength tripled while relative elongation decreased by 6.5 times. Irradiation of Mo by a flux of  $8 \times 10^{20}$  N/cm<sup>2</sup> leads to its complete embrittlement and raises the brittle-to-ductile transition temperature by more than 300°C. Swelling is another undesirable effect caused by radiation and can be observed in the temperature interval of 0.3-0.55° of the absolute melting point of a material being irradiated. Swelling is caused by formation of vacancy micropores or cavities measuring 100-150 Å. This phenomenon was noted in two domestic stainless steels used in reactor construction. Irradiation at 430-520° with an integral dose of  $3.6 \times 10^{22}$  N/cm<sup>2</sup> caused a volume increase of 5% in 1Kh18N10T steel and 1.2 in OKh16N15M3B. These percentages show that a steel alloyed with Mo and Nb is less sensitive to radiation swelling. On the other hand gas impurity atoms increase the degree of swelling. Evaluations have shown that in a 10-year operating period of a thermonuclear reactor the gas swelling, for example, in niobium, can rise to almost 30%. Thus, study of the phenomena of vacancy and gas swelling in nonfissionable materials and finding means of suppressing swelling is the most important problem of modern radiation materials science. Figures 6; references 27: 16 Russian, 11 Western.

YSSR

UDC 621.73.001.2

REFINEMENT OF THE METHOD FOR CALCULATING THE MAXIMUM DEFORMATIONS WITH NON-MONOTONIC DEFORMATION (DRAWING OF A STRIP THROUGH A SMOOTH WEDGE-SHAPED DIE)

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY, CHERNAYA METALLURGIYA in Russian No 12, 1977 pp 77-82 manuscript received 15 Nov 76

BOGATOV, A. A., KOLMOGOROV, V. L., MIZHIRITSKIY, O. I., and SEREBRYAKOV, A. V., Ural Polytechnical Institute

[Abstract] Recommendations are developed for the use of conditions formulated earlier for the failure of metals during nonmonotonic deformation in technological design calculations. In order to predict the failure of metal during a pressure-working process using the condition developed, one must solve the initial boundary value problem of the theory of plasticity and determine the stress-strain state; estimate the nonmonotonic nature of the deformations by segregating areas of deformation in a constant direction along the trajectory of movement of particles of the material; experimentally determine the variation in plasticity of the metal and lattice constant as functions of the stress state and temperature-speed conditions of the deformation process. An example is presented, in which it is calculated that the reduction in area per pass can be greatly increased in a drawing process without risking tearing of the metal. Figures 3; references 9 (Russian).

USSR

UDC 559.10

DESTRUCTION OF ZIRCONIUM CARBIDE BY A LASER BEAM

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 78 pp 105-107 manuscript received 21 Apr 75

GAZUKO, I. V., GRYAZNOV, I. M., and MIRKIN, L. I., Moscow

[Abstract] A study is made of the characteristics of fracture of a non-transparent brittle metal ceramic material (sintered zirconium carbide) by a laser pulse  $10^{-3}$  sec in length. The experimental installation consists of a type GOS-30M pulsed laser, a vacuum chamber with a specimen holder and an electronic circuit which records an oscillogram of the laser pulse, transmits an electric current through the specimen and records the transmission of the current. It is found that large cracks develop after  $10^{-3}$  sec following the end of the laser pulse. The processes within the crater formed do not influence the later formation and propagation of large cracks through the material. The large cracks develop after heating of a rather large volume of the material around the crater to temperatures corresponding to the appearance of thermal

stresses equal to the strength of the material. Heating the specimen to 700-1100°C increases the time of preparation for rupture and decreases the mean speed of crack propagation. Figures 5; references 3 (Russian).

USSR

UDC 539.67

#### SCATTERING OF ENERGY AND HARDNESS OF MARAGING STEELS WITH TITANIUM ADDITIVE

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 78 pp 108-110 manuscript received 10 Jul 76

KONDRATOV, V. M., and KOROSTELEV, V. M., Kirov Polytechnical Institute

[Abstract] This article studies the influence of various quantities of titanium on the hardening of chrome-nickel maraging steel (OKh12N8 base) in the initial (normalized) state and when heated as a result of dispersion hardening. It is found that titanium has a complex influence on the hardness of nickel martensite: comparatively small quantities (up to about 0.6%) cause softening of the steel in the initial state, and also after the initial stages of aging (at not over 450°C). The softening is maximal after normalization, decreases with increasing aging temperature and then increases again at over 650°C. Figures 4; references 6 (Russian).

USSR

UDC 621.793.14.669.181

#### THE MAXIMUM OF PLASTICITY, HARDENING AND SOFTENING PHENOMENA IN TWO-PHASE METALLIC MATERIALS

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 78 pp 61-64 manuscript received 18 Apr 77

MOVCHAN, B. A., DEMCHISHIN, A. V., and BADILENKO, G. F., Institute of Electric Welding imeni Paton, Academy of Sciences, Ukrainian SSR

[Abstract] Data are presented on the influence of the individual properties of particles of the second phase and the interphase interaction of particles with the matrix on the strength and plasticity of two-phase materials over a certain interval of content of the second phase including the condition  $D=\lambda$ , where  $\lambda$  is the mean free path between particles and D is the mean grain diameter of the metal matrix. The systems Ni-ZrO<sub>2</sub>, Ni-C and Cu-Cr are used as

examples, obtained by electron-beam evaporation and subsequent vacuum condensation. It is shown that where  $D=\Lambda$ , the plasticity maximum is reached. If a particle has low adhesion with the matrix, as in the case of Ni-ZrO<sub>2</sub>, the plasticity maximum appears simultaneously with an increased yield point. With high adhesion where  $D=\Lambda$ , the maximum of plasticity, is accompanied by a decrease in the yield point. These regularities can be used as criteria to facilitate the selection of compositions and methods of treatment of two-phase materials to produce the required combinations of strength and plasticity. Figures 2; references 7 (Russian).

USSR

UDC 669.187.26

PROSPECTS OF USING LOW-TEMPERATURE PLASMA FOR REDUCTION PROCESSES IN FERROUS METALLURGY

Moscow STAL' in Russian No 11, Nov 77 pp 974-977

RYKALIN, N. N., Academician, MANOKHIN, A. I., Doctor of Technical Sciences, FROLOV, V. A., Candidate of Technical Sciences, and TSVETKOV, YU. V., Doctor of Technical Sciences, Tulachermet Scientific Production Union and the Institute of Metallurgy imeni A. A. Baykov, Academy of Sciences USSR

[Abstract] Developments in the use of low-temperature plasma over the past few years in metallurgical reduction processes are discussed. To date, plasma techniques have mostly been applied to laboratory models but have shown much promise for use on a plant scale in the production of ferrous and non-ferrous metals at a high rate of productivity and lower cost. To study the ways and possibilities of using plasma to reduce iron ores, the Tulachermet Scientific Production Union built an experimental unit and conducted tests which showed that it was theoretically possible to achieve a specific productivity of 950 T/m<sup>3</sup> per day, which is 2-3 times higher than can be achieved by conventional metallurgical processes. The experimental work on this unit was directed by V. I. SIDOROV, Candidate of Technical Sciences, who was assisted by A. E. FRIDBERG, E. K. DOBRINKIY, V. A. TROFIMENKOV and L. I. SIVOLOBOVA. The basic requirements to be met by plasma application are spelled out and diagrams of two aggregates using plasma technology are presented. Figures 2; references 26: 22 Russian, 4 Western.

USSR

UDC 539.23.546.28

ELECTROPHYSICAL PROPERTIES OF POLYCRYSTALLINE SILICON FILMS DOPED WITH BORON

Minsk IZVESTIYA AKADEMII NAUK BSSR, SERIYA FIZIKO-TEKHNICHESKIH NAUK in Russian No 4, 1977 pp 26-29 manuscript received 15 Feb 77

GURSKIY, L. I., LESNIKOVA, V. P., RUMAK, N. V., and CHERNYKH, A. G., Physico-technical Institute, Academy of Sciences Belorussian SSR

[Abstract] A study was made to determine how the electrical characteristics of polycrystalline silicon films for the MOS IC technology depend on the doping process parameters. The test specimens were grown epitaxially in a vertical quartz crucible and doped either concurrently or after deposition by thermal diffusion at 1000°C. The substrate was thermally oxidized silicon and the deposition temperature was varied from 600 to 1100°C. The resulting grain size, the surface resistivity, the infrared absorption spectra, and the depthwise carrier concentration profile were measured after each process. The observed trends were interpreted in terms of the barrier model of electrical conductivity. Diffusion doping after deposition was found to produce films with a lower resistivity. Very thin films ( $< 0.15 \mu\text{m}$ ) had an anomalously high resistivity, owing to a loss of continuity, regardless of the doping process. The electrical properties of polycrystalline silicon films thus also depend on the structural characteristics. Figures 4; references 7: 5 Russian, 2 Western.

USSR

UDC 621.774.38

RAISING PRODUCTIVITY IN THE EXTRUSION OF ALUMINUM ALLOYS

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 2, Feb 78 pp 8-9

LUTOVNIKOV, P. P., BARANCHIKOV, V. M., and DENISOV, S. M.

[Abstract] The productivity of existing extrusion presses for high-strength aluminum alloys is limited by the maximum allowable flow velocity. The extrusion of tubes was studied with an experimental die and with the use of lubrication. An analysis of the process parameters and an evaluation of the product quality, in terms of mechanical strength and cracking resistance, indicate the feasibility of extruding tubes 82 mm in diameter at the rate of 3 m/min and of thus raising the productivity by 32%. The extrusion pressure ranges from 250 to 400 kgf/cm<sup>2</sup> and the temperature should remain below 460°C. Figures 3.

USSR

UDC 669.017

KINETICS OF DEFORMATION OF METALS IN THE SUPERPLASTIC STATE

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENI Y, TSVETNAYA METALLURGIYA  
in Russian No 1, 1978 pp 102-106 manuscript received 26 Oct 76

KUZ'MIN, S. L., LIKHACHEV, V. A., and NIKONOV, YU. A., Leningrad State Uni-  
versity, Department of the Theory of Elasticity

[Abstract] A report is presented on the superplastic behavior of a number of materials in torsion, i.e., under conditions such that the change in the geometric factor can be ignored. Superplasticity initiated by eutectoid breakdown, closeness of the composition to the solubility boundary, deformation in the area of the recrystallization temperatures and the scale effect are studied. The specimens were twisted in a special machine with clamps which were free to move in the axial direction, at loading rates of  $6.3 \cdot 10^{-4}$  to  $8.2 \cdot 10^{-2} \text{ s}^{-1}$ , temperatures from room temperature to  $300\text{--}700^\circ\text{C}$ , using solid, cylindrical specimens of aluminum, copper and aluminum-zinc alloy. The experiments established that all of the materials have typically great deformation before failure,  $3 \cdot 10^3$  to  $20 \cdot 10^3\%$  in relationship to an outside fiber. It is emphasized that the softening this implies is essentially postdeformational, with the specimen being deformed minute section by section, so that almost all of the metal at any instant is in the stage of postdeformational "rest" or softening. Superplasticity results from the fact that in the stage of deep structural reorganization of the substance, various recrystallization, relaxation and other accommodation processes begin to predominate, effectively preventing the appearance of high local stresses, the development of microfissures and micropores. Superplasticity is thus an alternative to failure in both the formal and the physical senses. Figures 4; references 12: 9  
Russian, 3 Western.

USSR

UDC 622.775

CYANIDING OF GOLD-CONTAINING ORES IN SEAWATER

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY, TSVETNAYA METALLURGIYA  
in Russian No 1, 1978 pp 67-70 manuscript received 18 Jan 77

KUZ'MINYKH, V. M., YAMPOL'SKAYA, M. YA., KURDYAYEV, YU. I., and CHURSINA, L. A., Far Eastern Institute of Geology, Academy of Sciences USSR

[Abstract] The purpose of the present study was to determine the influence of the basic components of seawater on the cyaniding of gold and to select conditions for cyaniding of quartz gold-containing ore in seawater. The possibility is proven of using seawater to cyanide gold-containing ores. One peculiarity of cyaniding in seawater is the limited alkalinity of the solution ( $\text{pH}=10.2$ ) resulting from the buffer properties of seawater. Grinding of the ore in a cyanide solution based on seawater is not recommended due to the increased consumption of cyanide; hardware should be made of rust-resistant materials. The precipitation of gold from cyanide solutions based on seawater by ion-exchange resins occurs rather readily. Figures 4; references 6 (Russian).

USSR

UDC 669.293

INFLUENCE OF ZIRCONIUM ON CREEP AND LONG-TERM STRENGTH OF NIOBIUM ALLOY WITH MOLYBDENUM, TITANIUM AND CARBON

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY, TSVETNAYA METALLURGIYA  
in Russian No 1, 1978 pp 107-109 manuscript received 21 Sep 76

ARZAMASOV, V. B. and VASIL'YEVA, YE. V., Moscow Higher Technical School imeni N. E. Bauman

[Abstract] This work presents a study of the influence of zirconium on the phase composition and heat resistance of the alloy  $\text{Nb}+15\%\text{Mo}+3\%\text{Ti}+0.07\%\text{C}$ . The specimens were heated to in a vacuum to  $1750^\circ\text{C}$ , held at this temperature for 1 hour and cooled at about  $600^\circ\text{C}/\text{min}$  in order to create a supersaturated solid solution of carbon in the alloyed niobium matrix. The results showed that the introduction of 1 wt.% Zr increases heat resistance and long-term strength at  $1100^\circ\text{C}$  due to the formation of finely dispersed carbides  $(\text{Zr}, \text{Nb})\text{C}$ , which serve as barriers to the movement of dislocations in the process of creep. Figure 1; references 3. (Russian).

USSR

UDC 535.211

THE INFLUENCE OF PULSED LASER RADIATION ON MATERIALS OVER A BROAD RANGE OF HELIUM PRESSURES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan/Feb 78 pp 24-30 manuscript received 15 Feb 77

RYKALIN, N. N., UGLOV, A. A., and NIZAMETDINOV, M. M., Moscow

[Abstract] Experimental data are presented on the effect of laser radiation on a target made of a number of materials in a chamber filled with helium over a broad range of pressures. The kinetics of the plasma phenomena were studied using high-speed photography. The range of pressure variation was 1 to 130 atm. It was found that the effect of the radiation changes with changing helium pressure. A difference is detected in the mechanism of formation and propagation of the plasma column through the laser beam in helium in comparison to nitrogen and argon. The dimensions of the plasma column generally decrease with increasing helium pressure, while the time of existence of the plasma increases. Figures 6; references 2 (Russian).

USSR

UDC 539.87:669.2955'24

PHYSICO-CHEMICAL INFLUENCE OF AQUEOUS SOLUTIONS OF COPPER-AMMONIA COMPLEXES ON MECHANICAL TREATMENT OF TITANIUM-NICKEL ALLOY

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan/Feb 78 pp 112-116 manuscript received 27 Jan 77

PERTSOV, N. V., VAYNBERG, R. R., PERTSOV, A. V., VOLODIN, YU. V., GERSHTEYN, V. A., and KOZLOV, V. M., Moscow

[Abstract] A study is made of the influence of a chemically active medium on the mechanical properties of a hard material during drilling under conditions which favor the appearance of the Rebinder effect. It is shown that copper-ammonia complex solutions can cause an increase in the drilling speed by ten or more times in comparison to drilling in air, in a soda solution or in a copper-sulfate solution. The effect results from the surface-active properties of copper tetra-ammoniate, causing a low-energy reaction in the cutting zone, indicating that the reduction in drilling force is due to a chemical reaction occurring on the surface, reducing its surface energy; the same method could be used to intensify various mechanical working processes. Figures 3; references 5: 2 Russian, 3 Western.

USSR

UDC 539.4

INFLUENCE OF SURFACE CONDITION ON THE SCALE VARIATION OF THE STRENGTH OF  
THREAD-LIKE AND MACROSCOPIC CRYSTALS OF AMMONIUM DIHYDROPHOSPHATE (ADP)

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan/Feb 78 pp  
156-157 manuscript received 24 Apr 77

PASTERNAK, N. A. and PREDVODITELEV, A. A., Moscow

[Abstract] A study is made of the tensile strength characteristics of ADP crystals using a special reversible device which automatically provides strictly axial loading of the specimen. ADP macrocrystals with polished surfaces are found to have high strength, comparable to that of polished thread-like ADP crystals, a result of the IOFFE effect, except that the high strength appears not at the moment the crystal is placed in the polishing medium, but rather after polishing and removal of surface defects. This indicates that polishing can significantly increase the strength of ADP crystals and, probably, other similar crystals. Figures 2.

CSO: 1842

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